POWER and THE ENGINEER

EVERYTHING ABOUT THE GENERATION AND TRANSMISSION OF POWER

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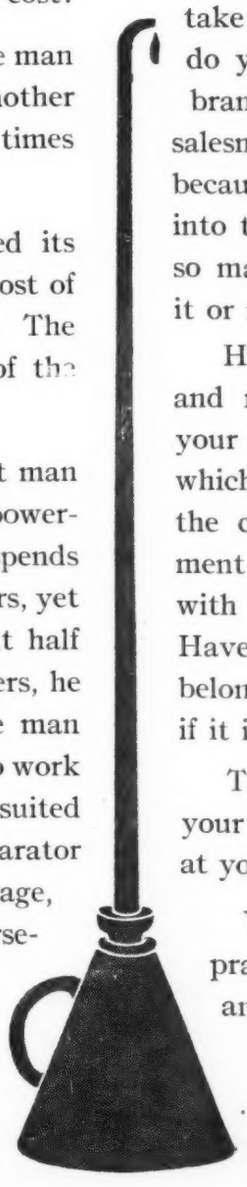
Do you know how much it costs to lubricate the cylinders of your engines for a year?

Have you any idea what it ought to cost?

Would you suppose that what one man is doing for less than a half cent, costs another man thirty cents, or more than sixty times as much?

Some months ago POWER asked its readers for figures on the amount and cost of the cylinder oil that they were using. The table on page 303 compares some of the returns to that inquiry.

Look at case No. 26. It costs that man but 0.47 cent per thousand horsepower-hours, while the man in case No. 67 spends 30 cents per thousand horsepower-hours, yet the latter's oil costs him only about half as much per gallon. In round numbers, he is using 114 times as much oil as the man in the first case. He has wet steam to work with and probably is using an oil not suited to his conditions. If he put in a separator and reduced his oil cost to the average, he would save 23.81 cents per 1000 horsepower hours. For a 300-day year, running ten hours a day at rated capacity, this would be a saving of about $50—quite a handsome return for an engine of this size.



We want you to become interested in this question?

What is your own practice? Do you take whatever oil they buy for you, or do you recommend the purchase of that brand which is handled by the chummiest salesman, or do you use a certain oil simply because it is the one which you have got into the habit of using? Do you feed about so many drops a minute whether she needs it or not?

Have you tried out a number of oils and made a study of the requirements of your machines, and tried to choose the oil which, all things considered, would make the cheapest grand total? Do you experiment to see how little you can get along with before groaning and wear commences? Have you studied to get the oil where it belongs? A little oil will do a lot of work if it is put onto the right spot.

Think this thing over, get some of your figures together and send them to us at your earliest convenience.

You will be interested to see how your practice compares with that of others, and others will be interested in yours.

If you have not all the figures exact, send along those you have and your estimate of the uncertain ones.

Features of the Manning Boiler

General Construction of Boiler, Operative Features and Its Status in Price, Floor Space Covered and Other Points as Compared with Water-tube and Tubular Boilers

BY S. F. JETER

The recent explosion of a Manning boiler, the first and only one which has failed disastrously in the twenty-one years that the type has been in existence, has caused so much discussion of this boiler generally and of special features of its design, that an article upon the subject by one who has for some time been identified with its inspection, design, making and operation, will be timely and perhaps interesting.

Fig. 1 illustrates the general construction of the boiler very clearly and is a part sectional view; it will be noted that the shell portions of the boiler which are subjected to the greatest stresses are entirely removed from contact with the furnace gases, and these plates can never be subjected to a temperature higher than that of the steam. This type of boiler is practically immune from explosion due to low water, for when the water level reaches a dangerous point, warning is usually given by the collapse of a tube or if this does not occur, due to a rapid fall of water level, as would result from the opening of a blowoff cock and the water reaches a point low enough for the crown sheet to be affected, the small amount of water left in the boiler renders serious explosive effect practically impossible. Two such explosions due to lack of water, of which the writer has learned, failed to move the boilers from their foundations; and there have been numerous instances of low water in this type of boiler without serious results.

The firm support of a boiler is one of the necessary features conducive to safe operation, and this is accomplished in the Manning type without relying upon the uncertain support of setting walls or the requirement of expensive structural work; for all that is necessary is a firm foundation upon which the cast-iron base may rest. If a brick base is used, as is frequently the case, there is required about 20 inches of brickwork above the floor line; this brickwork, is, in reality a part of the foundation and is in no way exposed to the heat from the furnace. The method of support relieves the boiler of practically all strains due to expansion, except such as may be produced by connections to the steam piping; this class of strains, however, is common to all types of boilers. The shell sheets of the Manning boiler being away from contact with the fire, permit the use of practically any thickness of shell necessary for high pressures, and this type of boiler can be constructed suitable for 200 pounds or more, in capacities up to 500 horsepower. The heat-transmitting surface may be made of practically uniform thicknesses regardless of the size of the boiler. The

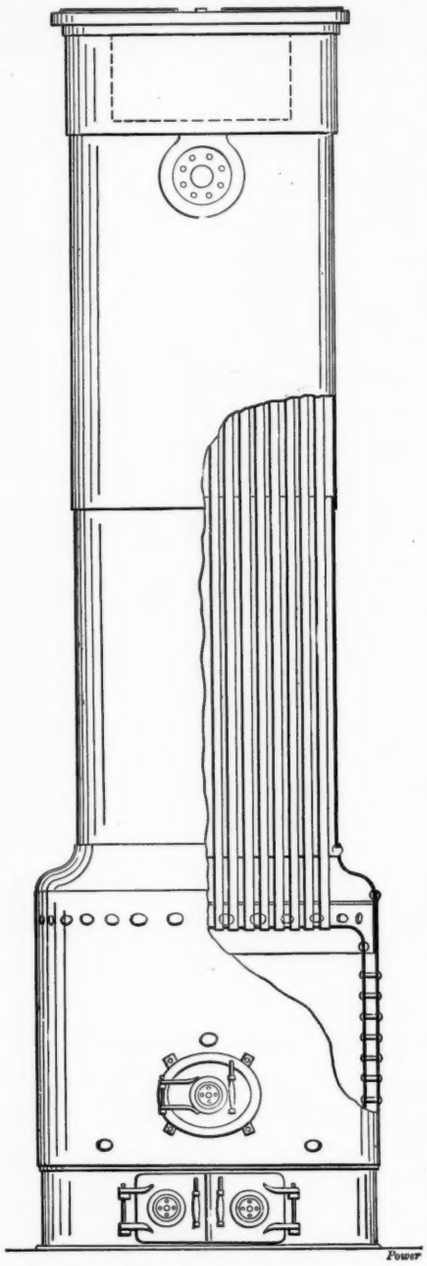


FIG. 1. PART SECTIONAL VIEW OF MANNING BOILER

usual thickness of furnace sheets is ⅜ or 7/16 inch, and the tube sheets are 7/16 to 9/16 inch thick. The most sensitive portion of this boiler is the crown sheet, which receives the direct heat of the furnace and contains as many expanded joints as there are tubes in the boiler; fully 90 per cent. of the operating troubles that have been experienced with this boiler, have been due to leaking tube ends.

The early designs of the Manning boiler, had the ogee flange down near the crown sheet and handholes in the barrel of the boiler, as illustrated in Fig. 2. This did not permit proper access for cleaning the crown sheet and was soon changed, the handholes being placed on a line with the crown sheet, by raising the ogee flange and locating these handholes in the outer sheet of the furnace, as illustrated in Figs. 1 and 5. The Bigelow Company, of New Haven, Conn., who have been among the fore-

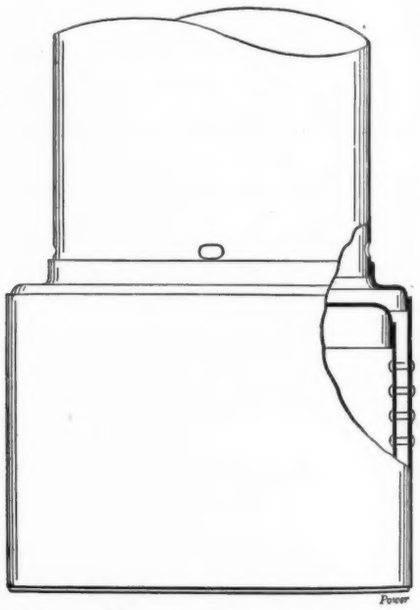


FIG. 2. ORIGINAL DESIGN OF MANNING BOILER. HANDHOLE IN BARREL

most builders of this type of boiler, early recognized the importance of being able to properly reach all portions of the crown sheet for cleaning and inspection. They devised a system of handholes, properly reinforced, and located around the crown sheet in such a manner that each tube aisle in both directions at right angles to each other could be reached. Fig. 3 illustrates in plan the relative positions of the handholes and tube aisles. Constructed with this cleaning device, the Manning boiler may be operated on any reasonably good feed water with entire success and safety, if proper care is used in removing deposits of scale-forming matter that tend to collect around the lower ends of the tubes and on the crown sheet.

The tube ends, and particularly those at the crown sheet, should be well beaded over on this sheet, as overheating from scale deposits or other causes tends to loosen the tubes in the crown sheet, and proper beading over of the ends prevents the pulling out of tubes in this condition until attention is attracted to them by leakage and they can be expanded. The proper beading of the tube ends also preserves the physical characteristics of the metal in the projecting ends of the tubes. A recent accident at Manchester, N. H., which was the first serious explosion of this type of boiler, was probably due secondarily to a failure to take the precaution of beading over the tube ends against the crown sheet.

While the design of the barrel above the ogee flange is the same in this boiler as required for any cylinder of similar diameter for withstanding internal pressure, the design of the outer furnace shell is not of the same nature, the only portion of this outer furnace shell which requires its thickness to be based on the diameter, is the short section above the staybolted surface. The force tending to rupture two cylinders of different diameters which are strongly stayed to each other, by pressure applied in the annular space between the two, depends upon the cross-sectional area of the space and is entirely independent of the diameter. This portion of the construction is illustrated in Fig. 4. The force tending to separate the plates is the area of the sheets in the cross-hatched portion, times the pressure, and is resisted by the four plates, the inner and outer plates being in tension. On account of the above facts the furnace plates along the staybolted surface may be made as thin as will admit of proper staying strength; for the same reasons almost any form of joint that can be made tight is perfectly safe for connecting together the sheets along this section of the boiler. Above the staybolted section the diameter becomes a factor in the determination of the strength, and this part should be designed along the same lines as the other cylindrical portions of the boiler.

It has been customary, on account of the requirement for strength of this upper portion of the outer furnace sheet, to make the entire sheet of suitable thickness for its diameter; this construction imposes rather severe conditions on the staybolts, for it prevents any flexibility of the sheet (due to its thickness) at the outer ends of the staybolts, which greatly adds to their liability to break at the connection to this thick sheet. The writer has modified the design by substituting a thin outer furnace sheet and reinforcing the portion above the staybolts with a continuous strap, this strap being made integral with the outer furnace sheet by rivets passing through the two plates at frequent intervals. Fig. 5 illustrates this form of construction.

The ogee flange was originally intended to serve as an expansion joint between the upper and lower portions of the boiler, the idea being that the variations in length between the tubes and shell while the boiler was in operation, rendered such flexibility at this point imperative. The first boilers of this type built had thin ogee sheets with short radius bends and relatively long flat surface, as illustrated in Fig. 6. This form was, however, later abandoned for the form illustrated in Fig. 7, which was made a true ogee curve with the radii meeting at the center and eliminating all flat surface; the sheets were also made very much heavier than in the original design. The reason for this change having been made, was on account of the tendency to develop cracks in the ogee sheet, about at the point indicated at *A* in Fig. 6. It was assumed by some engineers that these cracks (which were evidently formed by the flexure of the metal) were produced by differential expansion between the shell and tubes, the ogee having been thought necessary to care for this kind of action. Measurements were made while raising steam to demonstrate this to be a fact, however, practically the same variations as were found in such tests were reproduced, by a simple application of hydrostatic pressure, without the slightest temperature changes being involved, and investigation disclosed the fact, that the steam pressure on the bottom of the flat surface of the first design of ogee, as illustrated in Fig. 6, together with the thinness of the material, was responsible for the cracking; and it was effectually remedied by the new form and thicker material, as shown in Fig. 7.

Reasoning might have been applied in

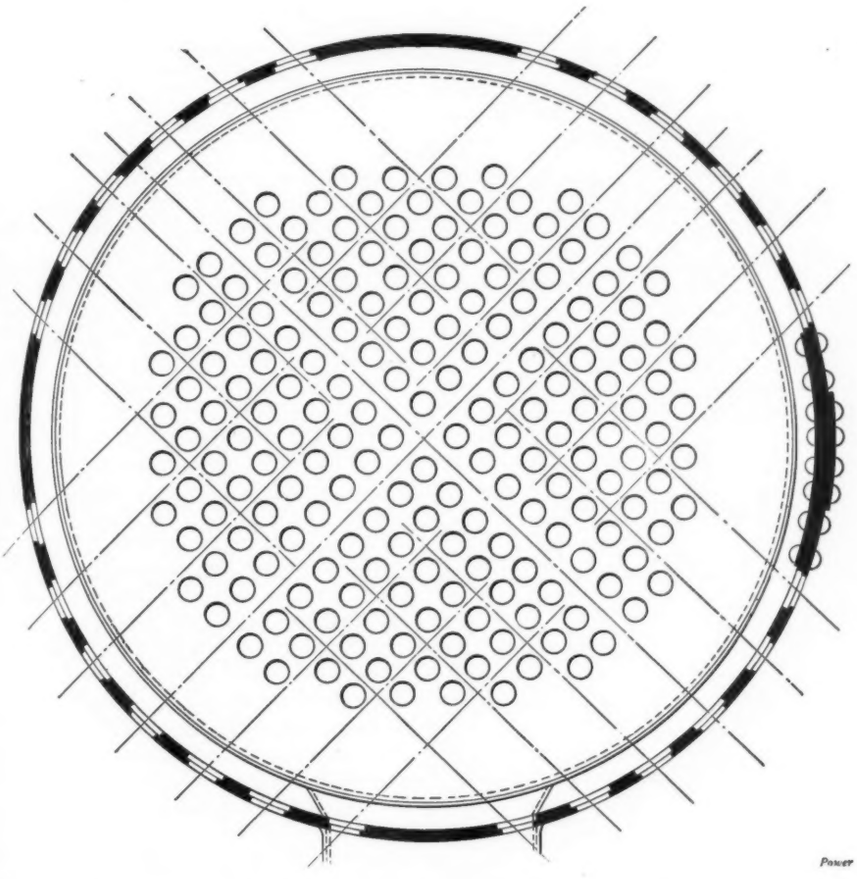


FIG. 3. LOCATION OF HANDHOLES AND TUBE AISLES IN THE BIGELOW CLEANING DEVICE

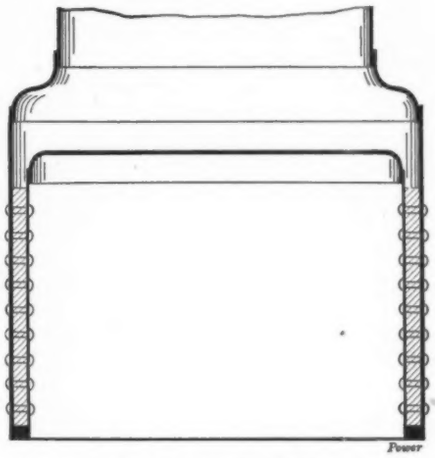


FIG. 4. AREA AGAINST WHICH PRESSURE ACTS IN TENDING TO RUPTURE TWO CYLINDERS STAYBOLTED TOGETHER

the first place to indicate the improbability of the differential expansion between the shell and tubes causing any considerable movement in the ogee flange. In the first place it is very doubtful if there exists an appreciable amount of differential expansion between the tubes and shell, except in the act of raising steam, and as will be noted from Fig. 3 (which is drawn to scale for a 130-horsepower boiler), there is considerable flat surface between the flange of the fire sheet and the outer row of tubes, and it is evident that a crown sheet ½ inch thick and with the amount of overhang shown, would not be capable of offering sufficient resistance to the thrust of the tubes, to produce any appreciable movement in the plate forming the ogee ring, or in other words, the flexibility of the outer edge of the crown sheet must have been greater than that of the ogee flange, even with the form first used. This portion of the crown sheet affords ample flexibility, as has been thoroughly demonstrated by the thousands of boilers in successful operation, with practically rigid ogee connecting plates.

The principal advantage derived from the ogee construction as used in the Manning boiler, is a slightly increased furnace area, without a corresponding increase of diameter or weight of the barrel portion of the boiler; this gain in furnace area is of considerable advantage in the large-size boilers, the ratio between the grate and water-heating surface (using 15- or 16-foot tube lengths), range from 1 to 47 in a 130-horsepower boiler to 1 to 59 in a 300-horsepower size; sizes above 300 horsepower are generally arranged with a brick furnace and are usually mechanically stoked, this arrangement permitting practically any ratio between grate and heating surface desired, and also admits of increasing the tube lengths to 20 feet.

A tube diameter of 2½ inches has been a standard with the Manning boiler, and no other sizes have ever been tried to the knowledge of the writer.

Operative Features

All critics of the Manning type of boiler, as well as other types in which the furnace is surrounded by water-heating surface, lay great stress on the poor facilities offered for the complete combustion of the fuel and such criticism is undoubtedly well founded. From a limited experience in the analysis of flue gas from this type of boiler, when burning bituminous coal, the writer doubts if it is possible to obtain thoroughly complete combustion with such fuel under regular operating conditions. Practically every other feature leading to economical performance, is obtained in the Manning boiler in practically ideal form, and these so completely outweigh the lone defect of slightly impaired combustion, that the economical evaporative performance of this boiler is remarkable, it is rarely ever equaled and doubtless cannot be surpassed by any other type in this respect.

In the first place, the uniform distribution of the furnace gases over the heating surface is practically perfect, regardless of the rate of driving, and the importance of this feature alone as contributing to high efficiency under average working conditions, can hardly be overestimated. All the surfaces for the transmission of heat are comparatively thin, which contributes to rapid and economical transfer of heat. All the radiant heat from the fuel bed is absorbed directly by water-heating surface. Owing to the short and direct passage of the gas from the furnace to the flue, the friction of the products of combustion through the boiler is greatly reduced, permitting a relatively small tube diameter practical, with ordinary draft conditions. The small diameter of tubes used, result in high velocity of the gas over the heating surface, and the most recent investigations relative to boiler performance indicate that this rapid flow contributes greatly toward producing a high rate of heat transfer. Owing to the fact that there are no heavy settings to absorb the heat, and that there is comparatively little water contained per square foot of heating surface (about the same as in the average water-tube boiler), the Manning boiler responds rapidly to changes in furnace conditions, and for the same reasons the standby losses are comparatively small. In plants operated only ten or twelve hours a day, as is the most usual custom, this feature of low standby losses is of considerable moment.

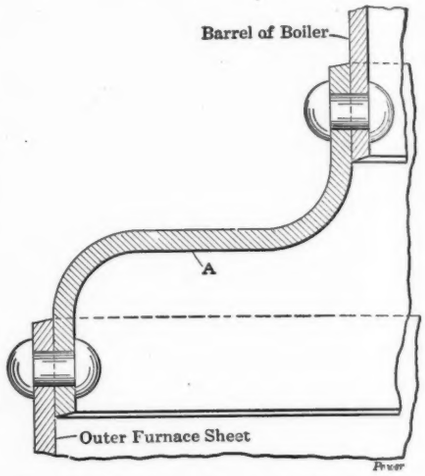


Fig. 6. Original Form of Ogee Ring

In addition to the elimination of all expense necessary for setting repair, the Manning boiler absolutely prevents all losses due to the infiltration of air in the usual form of brick settings, for the only possible way by which air can reach the heating surface is by way of the grate or firing door. It may be judged by the comparatively expensive methods adopted by some of the leading engineers to make boiler settings air tight, that the question of air infiltration is by no means an unimportant one as regards economy of fuel. The radiation losses in the boiler are reduced to a minimum; using 200 horsepower sizes as a basis for comparison, the average water-tube or return-tubular boiler has about 5 square feet of setting surface per horsepower for radiation of heat to the atmosphere, while a similar size Manning boiler has only 2.35 square feet of such surface per horsepower. With proper covering for the Manning boiler the loss per square

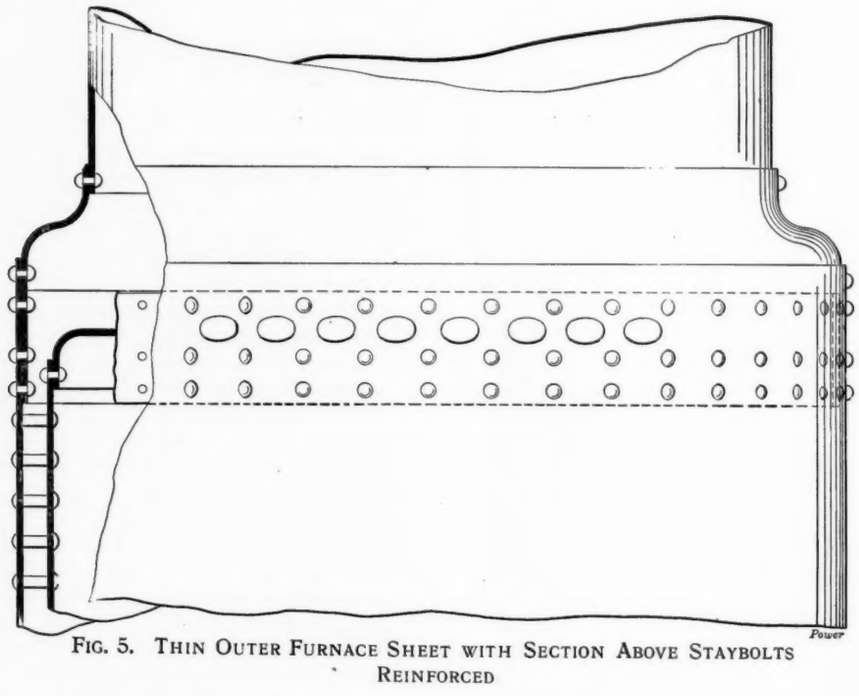


Fig. 5. Thin Outer Furnace Sheet with Section Above Staybolts Reinforced

foot of radiating surface will be less than for the same amount of brick-setting surface, and as this radiation loss is one that continues during the idle time in intermittent operation, it is of great importance to the boiler efficiency under operating conditions, although this is not directly indicated by an evaporative test.

Where the steam generated is to be used for power purposes, one of the strong points of this boiler that produces over-all plant efficiency, is that it furnishes superheated steam. The amount of superheat is slightly variable under different conditions, but it will average about 30 degrees Fahrenheit when the water level is carried at the customary point (4 feet below the upper tube sheet) and the boiler is operated near its rated capacity. The superheat furnished may be varied by changing the water level, lowering the level increasing the superheating surface and amount of superheat; a 500-horsepower boiler with tubes 20 feet long and with the water level about 7 feet below the upper tube sheet will give approximately 50 degrees superheat when operated at rated capacity. This superheat is obtained without extra first cost, and there is practically no such thing as repairs to the superheating portion of the boiler.

While the Manning boiler is a vertical boiler and requires considerable head room for its installation, it occupies much less ground space than other types of boiler per horsepower, for practically all of the space occupied consists of furnace area, which means that the limit of economy in floor space has been reached in this type of boiler. The floor space occupied by the Manning is about one-half that occupied by the average water-tube boiler of the same capacity. To indicate that the features which contribute to evaporative efficiency, as given in this article, actually exist and are by no means imaginary, reference may be made to a series of eleven tests of evaporative performance made on Bigelow-Manning boilers, at the plant of the Bristol Manufacturing Corporation, of New Bedford, Mass., in 1894, by Prof. J. E. Denton, of the Stevens Institute of Technology. All of these tests but one were made with bituminous fuel, and the average boiler efficiency obtained was 80 per cent., the lowest efficiency being 75.3 per cent. The results of this series of tests can probably never be exceeded by any type of boiler built.

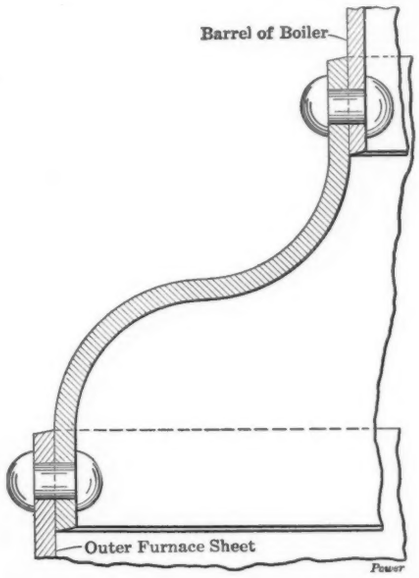


FIG. 7. IMPROVED DESIGN OF OGEE RING

Notwithstanding the fact that the Manning boiler excels in safety of operation, economy of floor space, evaporative efficiency, over-all plant economy and also supplies superheated steam, it has another point in its favor that is as fully appreciated by the commercial man as by the trained engineer, and this is low first cost. Comparing the price of the water-tube, return-tubular and Manning type of boilers on a basis of 200-horsepower sizes, the price per horsepower set and covered, ready for steam and smoke-flue connections, and with the water-tube and return-tubular boilers supplied with superheaters capable of delivering the same quality of steam as furnished by the Manning boiler, the prices per horsepower would range about as follows:

Water-tube	$16.75
Return-tubular	12.15
Manning	9.50

Omitting the superheaters on the first two the prices would be:

Water-tube	$15.00
Return-tubular	10.40
Manning	9.50

Doubtless many engineers who have had unsatisfactory experience with the vertical tubular type of boiler, owing to their inability to reach and clean the crown sheet, have become strongly prejudiced against this type; to such the writer would say, that the Manning boiler if equipped with the Bigelow cleaning device, is as different from the usual construction in regard to accessibility, as the open and closed type of feed-water heater.

Rules to Observe in the Boiler Room

Persons having the care of boilers should remember that explosions or other accidents are ofen due to lack of care on the part of attendants. The careful observance of the following rules will go far to prolong the life of boilers and to prevent casualties.

1. On entering the boiler room, ascertain if the valves between the boiler and water column are open. Then blow down water column, noting the return of the water in the glass, and test the gage cocks, until absolutely sure of the water level. This should be done at the beginning and end of each watch.

2. Open each door to the boiler at least once a day and look carefully for leaks at every possible point, noting tube ends, seams, and blowoff pipe in furnace. Examine carefully the fire sheets for bulges, bags or blisters.

3. Have all defects and leaks repaired without delay.

4. Safety valves are liable to stick on their seats; they should, therefore, be raised carefully at frequent intervals. Attach a small wire cable to safety-valve lever, pass it over a pulley, and bring the end down to a convenient place for ready service in lifting the valve. See that the outlet to each and every safety valve is full size of valve opening. When washing out the boiler, oil the safety valve with cylinder oil.

5. When the steam gage indicates the maximum load on the saftey valve approved in the last inspection report, the safety valve should be blowing off freely. If it does not, ascertain at once why not.

6. Keep gage cocks in good order and use them, as water glasses are very unreliable. Place tees or crosses at the bend of both pipes from boiler to water column; remove the plugs and clean these pipes when washing out the boiler.

7. In case of foaming, close the throttle long enough to show the true water level in the boiler. If the level is sufficiently high, feeding and blowing down will usually correct the evil. If foaming becomes violent, check the draft and use the surface blowoff freely. Ascertain the cause of the foaming, and take the necessary steps to prevent the evil.

8. In case of low water, cover the fire with wet ashes, or with green fuel if wet ashes are not available, and close the fire and ashpit doors. *Don't touch the safety valve. Don't turn on the feed water under any circumstances.* Let the steam outlets remain as they are until the boiler has been cooled off and examined to determine what damage has been done.

9. When connecting boilers, exercise great care. See that the pressures on the steam gages agree before attempting to open the steam valves. Open the valves very slowly, and, if provided with small bypass valves, use these before opening

the large valves. Never connect boilers unless the steam pressures agree. Many explosions have been caused by neglect of these precautions.

10. Do not close the damper entirely when there is fire on the grates, as gas may collect and result in an explosion as destructive of property as a boiler explosion.

11. Provide a V-shaped brick pier or asbestos cover to protect the blowoff pipe from direct flame in the furnace. Have this pipe extra heavy with malleable elbow. Once or twice a day blow down about 2 inches of water. The best times to use the blowoff are the first thing in the morning and directly after the noon hour, on each occasion before starting up; the circulation has then been retarded for some time and the scale-forming matter has had opportunity to settle near the blowoff. Open and close the blowoff cock slowly to avoid water-hammer.

12. Keep the boiler dry on the outside, as moisture will cause external corrosion.

13. Keep the brickwork tight so that cold air does not enter, as it will cause fuel losses. Fire lightly and frequently and endeavor by all means to save fuel for your employer. Endeavor to carry a uniform water level when the boiler is in service. Keep the feed pumps, injectors and all other appliances in good working order and as neat as possible.

14. Wash out the boiler at least once every month and more often if the feed water is bad. Do not allow oil or grease to enter the boiler; these foreign substances may cause overheating and burning of the plates and result in a bag, rupture or violent explosion. A solution of soda ash or a small quantity of kerosene fed continuously into the boiler is often beneficial in preventing or softening scale; when these substances are used open the blowoff cock once or twice a day as in rule 11. If kerosene is used, great care must be exercised to see that it is entirely gotten rid of by allowing a draft to blow through the boiler before bringing a naked light to the boiler or allowing anyone to enter the boiler, as an explosion may ensue or the fumes may overcome the person entering.

15. When a boiler is to be cleaned, allow the fire to die out, and leave the dampers open with the fire doors closed for at least twelve hours, when the steam gage should indicate no pressure. Then admit air on top, open blowoff cock, and allow the water to run out. Remove the upper manhole plate, and use vigorously a large hose with ample water pressure to dislodge loose scale, and wash out the boiler thoroughly. Now remove the lower manhole plate and all the handhole plates, and entering the boiler, remove the lodged scale at the turn of the flanges and below and between the tubes. See that all parts of the boiler are entirely free of scale and clean internally and externally from head to head, and see that the furnace is cleaned out from end to end. Examine carefully all parts of the boiler for defects, particularly the parts that are subjected to the direct heat of the furnace. See that any leakage at tube ends, or elsewhere, is stopped immediately, and that any tubes found bagged, or any other defects, are repaired at once.

16. Have all steam gages tested by the inspector. The gages should be placed on siphons and attached so that they may be readily taken down for test.

17. The inspection of a steam boiler is a matter of vital importance. When notified to prepare a boiler for internal inspection, proceed to cool down and clean the boiler as per instructions given in rule 15. Remove all scale, clean out the ashes and soot on the grates and in the combustion chambers, and sweep off the plates, heads and tubes, so that every part of the boiler may be examined and its exact condition determined. Have the boiler cold for the inspector when he arrives. Have the steam gage ready for testing, water-column connections open for inspection, and everything in readiness to facilitate a thoroughgoing inspection of the boiler and its connections.—*The Fidelity and Casualty Company of New York.*

Some Data on Cylinder Lubrication

On page 303 is presented a table showing cylinder-lubrication practice for 81 cases. The table is self-explanatory.

There is wide variation between the quantities of oil used per million square feet of cylinder wall rubbed over by the piston in various cases. This is as might be expected when we take into consideration the variations in type of apparatus, speed, quality and pressure of the steam, the quality of the lubricant and the method of its application.

It goes without saying that a very small part of the oil which is ordinarily used would lubricate the surfaces if it could be minutely and evenly applied. Water is an effective preventative of such application. Oil will not spread itself over a wetted surface any more than water will over an oily one. From this it would appear that there is more than heat units and cylinder heads to be saved by the use of dry-steaming boilers, steam-pipe coverings and separators.

Practical men are divided in opinion as to the best method of applying the oil. Some want it atomized, arguing that if it is diffused throughout the steam it will be carried to all parts of the surfaces in contact with the steam. Others prefer to keep the oil together, and let it trickle down the side of the pipe and be washed along over the surfaces by the flow of steam, contending that it is the valve and cylinder surfaces and not the exhaust pipe that they want to lubricate. Others favor the use of a force pump with a multiplicity of feeds, some going so far as to drill the seats of Corliss valves longitudinally and make several outlets direct to the undersurface of the valve. Still others, while admitting the effectiveness of such systems, claim that they can get the oil where they want it by means of a simple sight-feed cup in the steam main and thus eliminate many joints which are liable to leak, numerous passages which may become clogged and much bright work which must be kept clean.

The idea is prevalent that there is apt to be less trouble from a moderately smooth cylinder, one which shows the tool marks, than from a highly polished one, the rugose nature of the surface tending to retain the oil.

Much of the expense of cylinder lubrication and much of the annoyance caused by interruption of service, and all the cost of repairs made necessary by ineffective lubrication can be avoided by a careful selection of the oil for each particular service. It stands to reason that a heavy, low-pressure piston and the massive valves of a low-pressure cylinder at a comparatively low temperature and using the moisture-charged steam from the high-pressure will call for a different lubricant than will the lighter but hotter parts of the initial stage. Then it is apparent that oil suitable for low-speed work may not be efficient when used in high-speed machines.

Anyone who was familiar with the appearance of the Niagara Falls before the present power installations were built and opened, can settle the question as to whether the appearance of the falls has been affected, by the simple expedient of going to see for himself. Small though the total amount of water taken for power purposes, in proportion to the total amount passing over the falls, may be, it has been sufficient to cause the shallower portions of the overflow at the edges of the falls to become entirely dry, thereby greatly reducing the total length of the crest line.

No.	Estimated Horse-power.	Description of Engine.	Cylinders.	Stroke.	Revolutions per Minute.	Steam Pressure.	Sq.Ft. Rubbed Over per Hour.	Oil Used. Name or Description.	Oil Used. Price per Gal.	Amount Used per Hr., Pints.	Cost per Hr., Cents.	Pints per Estimated 1000 H.P. Hours.	Cents per Estimated 1000 H.P. Hours.	Pints per Million Sq.Ft. Rubbed Over.
1	1,350	Corliss triple expansion	20–34–52	60	65		1,084,000		28c.	0.69	2.42	0.511	1.79	0.636
2	675	Cross compound H.P.	26	48	81		265,800	No. 725 cyl. comp.	75c.	0.466	4.37	0.69	6.46	1.76
3	675	Cross compound L.P.	52	48	81		531,600	Capitol oil	35c.	0.666	2.91	0.99	4.33	1.25
4	975	Cross comp. St. Louis Corliss	22–44	48	85	140	706,500	No. 650 dark valve cyl.	50c.	0.104	0.65	0.107	0.67	0.147
5	975	Corliss compound	24–44	60	65		694,500		28c.	0.621	2.17	0.639	2.23	0.89
6	650	Hamilton Corliss cross comp	20–36	44	100	140	644,400	"600 W."	60c.	0.21	1.57	0.323	2.42	0.33
7	650	Hamilton Corliss cross comp	20–36	44	100	140 100° sup.	644,400	Oil of beeswax; 600 fire test cyl. stock & acidless tallow.	90c.	0.255	2.87	0.392	4.41	0.40
8	575	Corliss compound	18–34	48	85		555,900		28c.	0.465	1.63	0.81	2.84	0.84
9	875	Corliss tandem compound	24–42	48	65	110	539,600	Heavy body comp.	40c.	0.2	1.00	0.229	1.14	0.37
10	450	Russell cross compound	16–30	24	150		433,300	"600 W."	60c.	0.25	1.87	0.555	4.16	0.58
11	650	Cross comp. condensing	18–36	42	72		428,100	Improved high pressure cyl.	75c.	0.111		0.171		0.26
12	290	Cross compound H.P.	18	36	86	120	146,000	Best grade cyl.	60c.	0.645	4.34	2.22	15.80	4.42
13	290	Cross compound L.P.	34	36	86	120	276,000	Best grade cyl.	60c.	0.323	2.42	1.11	8.32	1.17
14	200	Harris standard cross comp	H.P. 16	18	200	110	150,800	Harris H.P. valve.	60c.	0.184	1.38	0.92	6.90	1.22
15	200	Harris standard cross comp	L.P. 28	18	200	110	263,900	Rarus.		0.131		0.65		0.50
16	400	Cross comp. St. Louis Corliss	14–28	42	85		393,000	No. 650 dark valve.	50c.	0.09	0.56	0.225	1.41	0.23
17	450	Corliss cross comp	18–30	36	84		380,000	"600 W."	60c.	0.417	3.13	0.927	6.95	1.10
18	290	Phoenix Iron Works	14–24	18	210	130	376,100		43c.	0.167	0.90	0.58	3.10	0.44
19	200	Russell tandem comp	13–20½	20	210		368,200	"600 W."	60c.	0.167	1.25	0.835	6.25	0.45
20	225	Corliss cross compound H.P.	16	36	84		126,800	Best grade cyl.	60c.	0.645	4.34	2.86	21.45	5.10
21	225	Corliss cross compound L.P.	30	36	84		237,500	Best grade cyl.	60c.	0.323	2.42	1.43	10.72	1.36
22	225	Buckeye tandem comp	12–21	21	200		363,100	"600 W."	60c.	0.25	1.87	1.111	8.33	0.69
23	450	Ingersoll cross compound	18–30	24	100		302,000	"600 W."	60c.	0.167	1.25	0.371	2.78	0.55
24	200	American ball compound	10½–20½	12	285		277,600			0.273		1.365		0.98
25	180	Westinghouse automatic comp	11–19	11	300		259,300	No. 725 cyl. comp.	75c.	0.083	0.78	0.461	4.32	0.32
26	160	Cross comp. Meyer valves	11–18	14	165	115	175,400	Best high grade mineral.	50c.	0.012	0.075	0.075	0.47	0.07
27	160	Tandem comp. piston valve	10⅜–18	18	115	115	172,100	High grade mineral.	50c.	0.037	0.23	0.231	1.44	0.21
28	70	Ingersoll cross comp	8–12	12	150		94,300	"600 W."	60c.	0.083	0.62	1.185	8.89	0.88
29	450	Piston valve	30	48	95	150	357,800	"Cyl. oil No. 10."	25c.	0.417	1.30	0.927	2.90	1.16
30	450	Double eccentric Corliss	30	48	84	150	318,000	"Cyl. oil No. 10."	25c.	0.5	1.56	1.111	3.47	1.57
31	290	Corliss	24	48	102		308,100			0.091		0.314		0.29
32	290	Harris Corliss	24	48	100		302,000			0.091		0.314		0.30
33	290		24	42	93	120	245,500		60c.	0.369	2.77	1.272	9.55	1.50
34	200	Greene	20	44	100		230,200			0.91		0.455		0.39
35	160	Sioux Corliss	18	42	105		207,900	"600 W."	60c.	0.125	0.94	0.781	5.86	0.60
36	290	Harris Corliss	24	48	65		196,200			0.19		0.655		0.97
37	200	Corliss	20	36	102	150	192,200	"Cyl. oil No. 10."	25c.	0.167	0.52	0.835	2.61	0.87
38	130	New Brown	16	36	125	110	188,800	Harris high-press. valve.	60c.	0.118	0.88	0.908	6.81	0.63
39	250	Atlas single valve automatic	22½	30	105	110	183,500	Buckeye cyl.	28c.	0.15	0.525	0.600	2.1	0.82
40	160	Ames	18	16	230		173,700	Capitol oil.	35c.	0.22	0.96	1.375	6.00	1.27
41	160	Corliss	18	36	100		169,800		90c.	0.1	1.12	0.625	7.04	0.59
42	130	High speed automatic	16	16	250	115	167,800	High grade mineral.	50c.	0.015	0.094	0.115	0.72	0.089
43	130	High speed automatic	16	16	250	115	167,800	High grade mineral.	50c.	0.22	0.14	0.169	1.06	0.13
44	150	Piston valve engine	17½	16	220	80	161,500	Light colored oil.		0.03		0.2		0.19
45	130	Slide valve throttling governor	16	30	126	95	158,200	Capitol.	35c.	0.1	0.44	0.769	3.36	0.63
46	120	Single valve auto. Fitchburg	15½	14	275		156,200		28c.	0.138	0.48	1.15	4.02	0.88
47	160	Atlas four valve	18	15	220	125	155,900	Rarus cyl.		0.094		0.587		0.60
48	130	Harris Corliss	16	36	100	65	150,900	Harris std. grade.	60c.	0.15	1.12	1.153	8.64	0.99
49	130		16	38	92		146,600	Compounded oil	43c.	0.15	0.81	1.153	6.20	1.02
50	100		14	14	280		143,200	Model cyl.		0.045		0.45		0.31
51	240		22	23	106		140,500	"Eureka cyl."		0.105		0.437		0.75
52	160	Wright Corliss	18	42	70	85	138,800	Capitol	35c.	0.125	0.55	0.781	3.41	0.90
53	130	Nordberg Corliss	16	36	90		135,800	Valvaline	75c.	0.2	1.87	1.538	14.38	1.47
54	100	Robt. Armstrong automatic	14	14	260	125	133,500	"600 W"	60c.	0.15	1.12	1.5	11.22	1.12
55	130	Corliss	16	42	75		132,100		28c.	0.138	0.48	1.061	3.71	1.04
56	100	Corliss	14	36	100		132,000	"600 W"	60c.	0.06	0.45	0.6	4.50	0.45
57	200	Slide valve	20	30	80	80	125,800			0.018		0.09		0.14
58	160	Greene	18	30	85		120,200	"600 W"	60c.	0.03	0.22	0.187	1.46	0.25
59	100	Variable speed, St. Louis Corliss	14	36	90	135–140	118,800	No. 650 dark valve cyl.	50c.	0.045	0.28	0.45	2.82	0.38
60	85	Atlas automatic	13	18	190	125	116,800	"600 W" vacuum cyl.	60c.	0.067	0.50	0.788	5.90	0.57
61	110	Ames	15	14	212		116,600	Capitol	35c.	0.11	0.48	1.0	4.37	0.94
62	100	Automatic piston valve	14	14	223		114,500	High grade heavy	50c.	0.125	0.78	1.25	7.8	1.09
63	130	Nordberg Corliss	16	32	85	110	113,800	Dark heavy cyl. with graph.		0.115		0.885		1.01
64	70	Ideal	12	12	300	100	113,100	Capitol cyl.	35c.	0.083	0.36	1.186	5.18	0.73
65	70	Buckeye	12	21	165		108,900			0.1		1.428		0.92
66	100	Corliss	14	36	80		105,800			0.049		0.49		0.47
67	70	Atlas single valve automatic	12	18	180	110 very wet	101,800	Buckeye cyl.	28c.	0.6	2.1	8.57	30.0	5.94
68	70	Corliss	12	36	90		101,800			0.0835		1.19		0.82
69	70	Bates Corliss	12	36	88	100	99,500	Capitol cyl.	35c.	0.2	0.87	2.857	12.48	2.01
70	70	St. Louis Corliss	12	36	85	135–140	96,350	No. 650 dark valve cyl.	50c.	0.045	0.28	0.643	4.01	0.47
71	70	New Brown	12	34	90	80	96,200	Franklin oil	75c.	0.1	0.94	1.428	13.38	1.04
72	50		10	14	260	80	95,400	Capitol cyl.	35c.	0.055	0.24	1.1	4.81	0.58
73	100	Atlas	14	20	130	80	95,400	Capitol cyl.	35c.	0.2	0.87	2.0	8.74	2.10
74	50	McEwen	10	12	300		94,400	W. P. Miller's cyl. comp.	75c.	0.04	0.37	0.8	7.50	0.42
75	70	Fitchburg	12	30	100	90	94,400		45c.	0.055	0.31	0.786	4.42	0.58
76	70	Slide valve	12	14	210	150	92,500	Flake graph. with eng. oil		0.083		1.185		0.90
77	40	Ball	9	12	300		84,750	Pomo oil		0.167		4.175		1.97
78	50	Atlas	10	12	240		75,400		60c.	0.045	0.34	0.9	6.75	0.60
79	50	Center crank	10	15	170		66,800			0.083		1.66		1.24
80	85		13	17	105	100	60,900	"600 W"	60c.	0.125	0.94	1.47	11.02	2.05
81	50	Slide-valve	10	12	250	100	31,410	Premium valve oil		0.091		1.82		2.90
											Averages	1.014	6.19	0.97

Some Useful Lessons of Limewater

Simple Yet Accurate Methods of Obtaining the Flashing Point of Oils, Measuring the Viscosity and Detecting the Presence of Water

BY CHARLES S. PALMER

For determining the flashing point of an oil, rig up an apparatus like that shown in Fig. 1. This consists of a plain beaker about three-quarters full of oil, resting on a wire gauze to protect it from

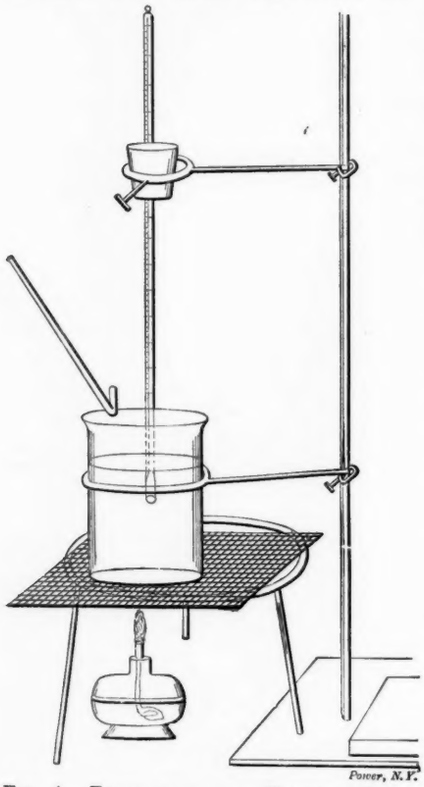


FIG. 1. EQUIPMENT FOR TETSING FLASH POINT OF OILS

the direct flame of the lamp underneath and surrounded by a ring to support the beaker and to keep it from spilling and tipping; for hot oil is very unpleasant and may be dangerous. Into the oil there is set a spindle thermometer reading either in Centigrade up to 360 degrees, or in Fahrenheit up to 600 degrees. This thermometer is inserted in a cork held in a clamp that is mounted on an iron stand which also supports the ring surrounding the beaker. It is well to lay a brick or some heavy weight on the flat base of the iron stand to steady it.

The operation of taking the flashing point is very simple; fill the beaker three-quarters full as described, place a small flame not over an inch and a half long, if a bunsen flame, though a common candle will give heat enough for most flashing points if the flame is kept so low that the wire gauze will not get sooty. Have a little tray of small splinters of soft wood, light them one at a time, and hold each burning splinter for a moment or two just over the heated oil. If the oil does not flash at ordinary temperatures, and very few oils will do this, it is not necessary to apply a burning splinter again until the oil is so hot that it begins to give off a perceptible vapor. As soon as you see this vapor, watch the thermometer as it rises and apply the flame of the burning splinter near the upper surface of the oil in the beaker at every increase of five degrees in temperature; and as the vapor grows thicker and heavier in body apply the splinter constantly at intervals of every degree or two. Pretty soon you will notice a little snapping movement and soon after this you will clearly see the vapor flash from the splinter flame down onto the surface of the oil. Quickly read the thermometer and that is the flashing point of the oil. If you place a dark surface behind the beaker of oil and in line with it, you can catch the flame at the flashing point more easily with the eye. If there is any uncertainty in your mind about this flashing point, repeat this experiment with another beaker of this same oil; with a little practice you will get the same results always within a degree or two. This method is called the open-cup method. Some chemists recommend the use of a stirring rod to keep the heated oil even in temperature and some recommend bringing the thermometer to a certain temperature and then removing the flame a moment to let the mercury in the thermometer adjust itself to the temperature of the oil, before taking the flash with the burning splinter. There is no particular objection, nor is there any particular advantage, in this; but, if you do it in one case you should do it in all cases; otherwise you will obtain slightly different results. The point is to have one system and follow that.

Now you will find several different pieces of apparatus recommended in books as standard according to law in certain States; some of these instruments are fairly reliable and some of them are simply nuisances. Indeed it is doubtful if any of them will give any better results than an expert can obtain with the simple open-cup method. Of course, it is impossible to have all parts of the beaker at the same temperature; but if the oil in the lower part of the beaker is hotter than that in the upper part, so also is the mercury in the lower part of the thermometer bulb hotter than that in the upper. This open-cup method has been criticized for years by certain of the great oil companies because it does not represent the conditions of dangerous liability to explosion existing, say, in a closed kerosene lamp; and hence, to the scandal of chemists, certain closed-cup methods have been devised, supposedly to imitate the conditions of the closed bowl of a lamp, but really perhaps to allow the oil to reach a higher temperature before it would give off a vapor under conditions which would allow it to flash. If you have any doubt about the accuracy of the open-cup method under ordinary conditions and with ordinary oils, all that you have to do is to try it systematically. You will find that as an oil rises in specific gravity, its flashing point will correspondingly rise and as it falls off in specific gravity, its flashing point will be correspondingly lowered; thus in working with a medium-grade petroleum oil of specific gravity 0.905 to 0.910 the flashing point may run from 208 to 214 degrees Centigrade.

There are several points that one should notice in taking the flash point of the lighter oils; thus gasolene and benzine may flash at ordinary temperatures, and if they do not they should *not be placed over a flame to be heated,* but in a tin cup of warm water. In this case they will have to be stirred because the heat does not come mainly from below but from the sides. Also note that the flashing point and the igniting or the burning point of the heavier oils are some distance apart; but the flashing point and the burning point of gasolene and benzine, particularly when heated in a cup of hot water, are so close together that one can easily have a conflagration on his hands. To avoid this remember that a few drops of the new solvent, carbon tetrachloride, CCl_4, if sprinkled into a beaker of burning gaso-

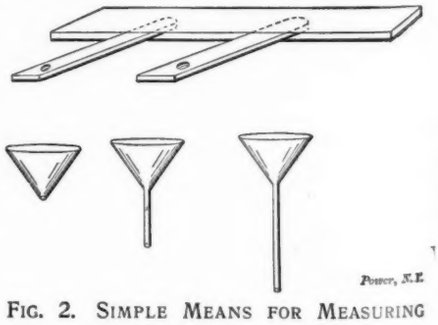


FIG. 2. SIMPLE MEANS FOR MEASURING RELATIVE VISCOSITIES

lene will extinguish it at once. This point is worth knowing and it is said that some plumbers mix a little of this carbon tetrachloride with the gasolene in their blast lamps to prevent it from exploding. Carbon tetrachloride is a heavy, volatile

liquid which is noninflammable; but it cannot be used safely to extinguish the fires of hot and burning heavy oils because its very volatility will drive off more of the hot oil into vapor, at least that is my experience; but it is valuable for extinguishing fires of lighter burning oils.

You can see how closely the specific gravity and the flashing point are connected with each other practically; but there is another point connected with the heating of an oil to get its flashing point which may be mentioned here, and that is that if there is any water mixed with the oil in fine drops, its presence will be shown by a snapping and spitting as you heat the oil. There may be so much water that this snapping and spitting will be almost explosive, and such cases do occur although they are extremely rare with good oils.

The next point to consider in the analysis of oils concerns what is commonly called viscosity. An oil is viscous when it has a thick, sticky body, like glue; and by viscosity in general, as applied to oils, what is meant is really a mixture of several qualities and no one instrument has ever been devised which will measure all of these qualities at once. The general question of viscosity concerns not only what is meant by the "body" of an oil but also what is meant by its "tack;" that is, its stickiness. There are also one or two other qualities of oils which are included in the general determination of viscosity. This subject of viscosity really concerns what is meant by the old-fashioned names of cohesion and adhesion. Cohesion is the internal stickiness of a substance by virtue of which its particles cling to each other; adhesion is the external stickiness by virtue of which it clings to other things.

The best way to get a notion of what is meant by the viscosity of oil is to consider a special example. In Fig. 2 there are shown three funnels, one broken off at the neck, one with an inch or two of the stem remaining and one with three or four inches of stem with the lower part drawn out to a fine tube. With this simple apparatus and an ordinary watch you can make comparative tests on the viscosity of oils which will serve your purpose as well as apparatus costing hundreds of dollars. Thus, suppose that you have a standard engine oil and its viscosity is given to you, say, as 200, as measured by a certain apparatus, whatever that may be. Now take a certain quantity of this oil, say, an ounce or two ounces, pour it into the funnel without a stem, holding your finger over the lower end of the funnel till all the oil is in the funnel and then with your eye on your watch, suddenly remove your finger and let the oil fall into a cup, noting the number of seconds that it takes the oil to flow entirely into the cup or almost entirely; for instance, you may judge the flow to have ceased when the steam breaks into drops. Suppose an ounce of oil took 70 seconds to drain through the funnel without any stem; then that would be your measurement of the viscosity of that oil according to this method. Now compare it with some other oil purporting to have the same specific gravity, boiling point and viscosity. You may find that the second oil may have a specific gravity and a boiling point close to that of the first and the viscosity like the first of one ounce in 70 seconds, if measured in the funnel without the stem. But try the oils first in the funnel with two or three inches of stem when you will find that the viscosity may mount from 70 up to several hundred seconds, on account of the friction of the side walls of the stem; and if measured in the third funnel with the long stem the viscosity figure may run up much higher. Now two oils may seem to be very much alike if measured in the first funnel; yet their viscosities may be very different if measured in the second and especially if measured in the third funnel; and still they may be very much alike in specific gravity and flashing point. If you should test these oils by the specific-gravity spindle you would notice something which would also indicate a great difference in their viscosities; that is, the rate at which the specific-gravity spindle would sink in the little cylinder of oil to its true level and the time required for the spindle to find this level. In measuring the specific gravity of a thick oil, it is not safe to take the reading for half an hour or even longer, so slowly does the oil yield to the very slight pressure of the weight of the hydrometer and so great is the friction of the oil between the outside walls of the spindle and the inside walls of the cylinder. This suggests that ordinarily the makers do not provide cylinders for the hydrometers quite large enough, especially in the use of heavy oils. Hence, in taking the specific gravity of heavy oils you must let your spindle stand in the cylinder over night to be sure that it has time enough to reach its true level; and if the cylinder carrying the oil and the hydrometer stands in a can of water filled up to the level of the oil you can easily take the temperature of the oil by putting a thermometer into the water in the morning, for the water and the oil will reach the same equilibrium of temperature some time during the night.

This method of measuring the viscosity will guide you in comparing any sample of oil with the standard sample; and if the standard sample comes to you with a certain viscosity you can easily compare your viscosities with those of the standard by the old "rule of three" or simple proportion; thus, if your standard sample comes with a viscosity of 200 and you find it to be 70 seconds for an ounce in the first funnel while another sample is 90 seconds for an ounce in the first funnel, all you have to do is to write your proportion:

$$\frac{90}{70} \times 200 = x,$$

which gives 257 as the value of x.

If you find that the viscosity of your two samples of oil in the second funnel are 500 and 700 seconds, then your formula will be:

$$\frac{700}{500} \times 200 = 280,$$

which is quite different from the value of 257 obtained with the first funnel; the figures for the viscosities for the third funnel may be still more different, and yet your determination may be quite as reliable as those made by any of the expensive pieces of apparatus, for these expensive pieces of apparatus frequently fail in measuring viscosities because they try to do everything at one operation, whereas your simple funnels represent certain conditions differing from each other and may bring out different properties of the oils. In stating the simple proportions as given above I have assumed that the viscosity measurements can be directly compared with each other, but it is quite possible that under certain conditions one might have to use either the squares of the times or the cubes of the times because the laws governing the practical friction of liquids have not yet been entirely cleared up.

This introduction to the study of viscosity is a part only of the general subject of the "body" of an oil. I heard an old marine engineer say the other day, with rather a sneer for the technical examination of an oil, that all that he needed to do was to pour a little of an oil out into his hand, smell it, taste it, feel it, rub it hard with a finger of the other hand, and then watch it to see if it stayed there. If it did it was a good oil. Now I am not going to make fun of any of the wit and wisdom of practical men; for a good man who knows his engine and his oils may be able to find out forty things from a mere hand sample and there are a great many homely and off-hand tests which can be made in this way which cannot take the place of exact testing but which can help a great deal when one is in a hurry. We will consider some of these tests in the next lesson.

Recently gathered steam-turbine statistics show that although the first steamer was equipped with turbines as recently as 1901, there are now 64 vessels carrying this equipment, the aggregate horsepower represented being 603,200. It is estimated that because of the lower pressure which can be used with the turbine, no less than 120 tons of weight was saved in the boiler room of the largest of the turbine-propelled liners.

Hoisting Engine Locking Levers

BY WARREN O. ROGERS

Doing work by main strength and nothing else is something that can be seen most anywhere, and at almost any time. And hoisting work is no exception to the rule. Here the engineer, whose time is taken up in manipulating various levers, and who is obliged to work several at one time, will frequently prefer to do so rather than to use a device with which he is not acquainted, but which, if thoroughly understood, would make his work easier.

The hoisting engineer, in working his several levers at one time, is obliged to get into some grotesque positions. Figs. 1 and 2 show how the body is contorted while attempting to operate a hoisting engine not equipped with a proper locking device.

Some years ago a practical derrick man made a device for locking the levers in position, the intention being to simplify the operation of the double friction-drum engine in handling a boom derrick where both the load and boom were continually being raised and lowered.

To the novice it looks simple enough to operate a double friction-drum engine, but when equipped with the regular brake, ratchet and pawls, considerable skill is required to lift or lower the boom, and at the same time handle the load. A new or inexperienced operator while attending to one function is liable to neglect the other, and an accident is invited. If, not being used to the work, the engineer only attends to one operation at a time, it is evident that much valuable time is lost in doing the same amount of work an experienced man would do.

The device mentioned was designed for the benefit of the man who, for any reason, found it difficult to attend to the various operations at the same time, in order to do the work quickly and with safety. It is said that a man cannot do two things at once, but the hoisting engineer, under ordinary circumstances, must do so, and that is just what he does do. By the usual method he must give his attention to two friction-drum levers, two foot brakes, two pawls, and a throttle-valve lever. Before he can operate these levers he is forced to assume a most uncomfortable position. For instance, in hoisting a load, and at the same time lowering the boom, some operators throw one leg over the front friction lever while controlling the lowering of the boom with the friction lever of the upper drum. This makes it difficult for the operator, and is apt to hinder him from seeing the motions of the signal man. With the new arrangements of levers, the operator stands as shown in Fig. 3, which is quite a contrast to the positions shown in Figs. 1 and 2.

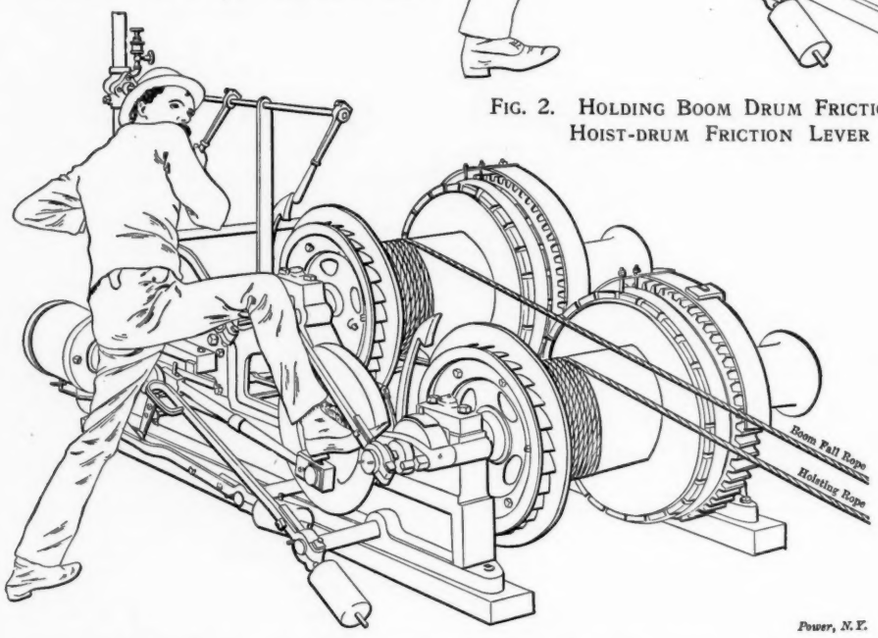


FIG. 1. HOLDING FRICTION LEVER ON HOISTING DRUM WITH RIGHT KNEE, LEFT HAND ON UPPER FRICTION LEVER AND RIGHT HAND ON THROTTLE

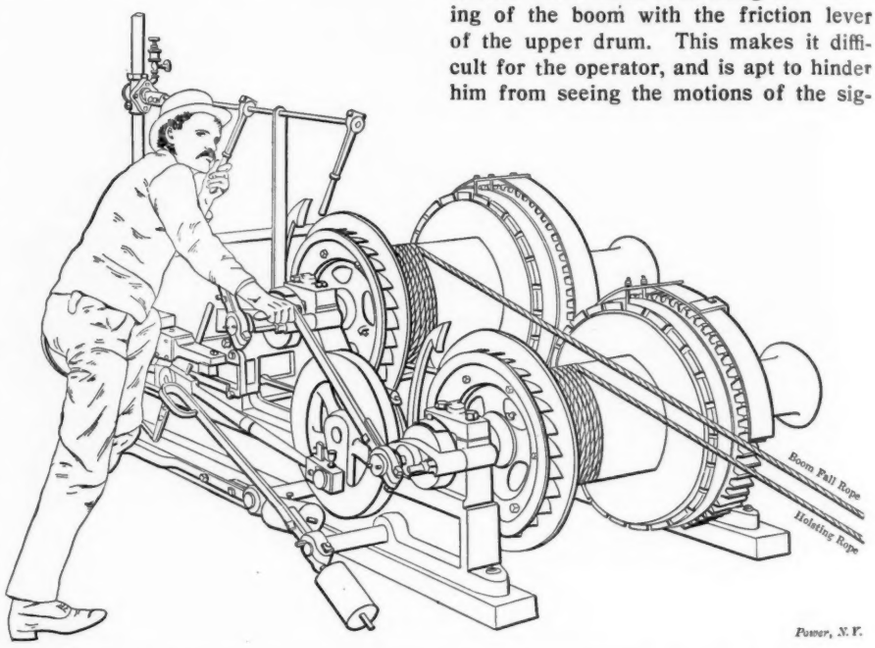


FIG. 2. HOLDING BOOM DRUM FRICTION WITH LEFT ELBOW, RIGHT HAND ON HOIST-DRUM FRICTION LEVER AND LEFT HAND ON THROTTLE

In Fig. 4 is shown the arrangement of the friction-lever latch on the front drum, with the improved device. The lever is arranged with a thumb latch and detent which engages with serrated teeth in a quadrant, thus allowing the operator to place the lever in any position. With this arrangement the drum is securely locked, and the operator can give his attention to the hoisting load.

The lever of the upper friction drum has an extension piece with a pin which moves on the curved surface of an oscillating lever, having a notch at the lower end, engaging with a pin extending from the side of the foot-brake lever. (See Fig. 5.) When the friction lever is moved to throw the drum into gear, the pin on the end of the friction lever presses against the curved parts of the oscillating lever and releases the foot brake. Moving the levers back and placing the foot on the foot-brake lever for a moment, the oscillating lever drops back into its original position and engages with a pin on the foot-brake lever, which locks the brake on the drum.

When the operator starts to hoist, he first throws the front friction-drum lever enough to hoist the load, and is then free to raise or lower the boom by means of the upper drum. If the boom is to be lowered, both this friction lever and foot brake are used, so that the oscillating lever will not fall into place and lock the brake. By this method, as soon as the boom has been lowered far enough, full pressure is put on the brake lever, and the friction lever thrown to the out position, when the oscillating lever will fall into place and lock the drum fast.

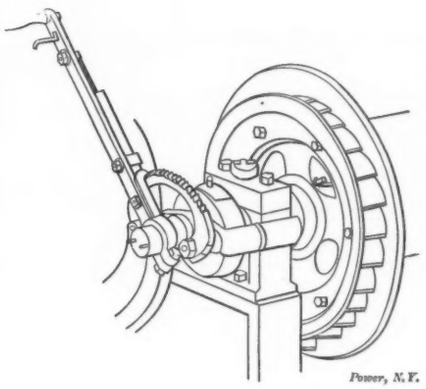


FIG. 4. LATCH HOLDING LEVER WHERE SET AND RELIEVING THE RIGHT HAND OF THE OPERATOR

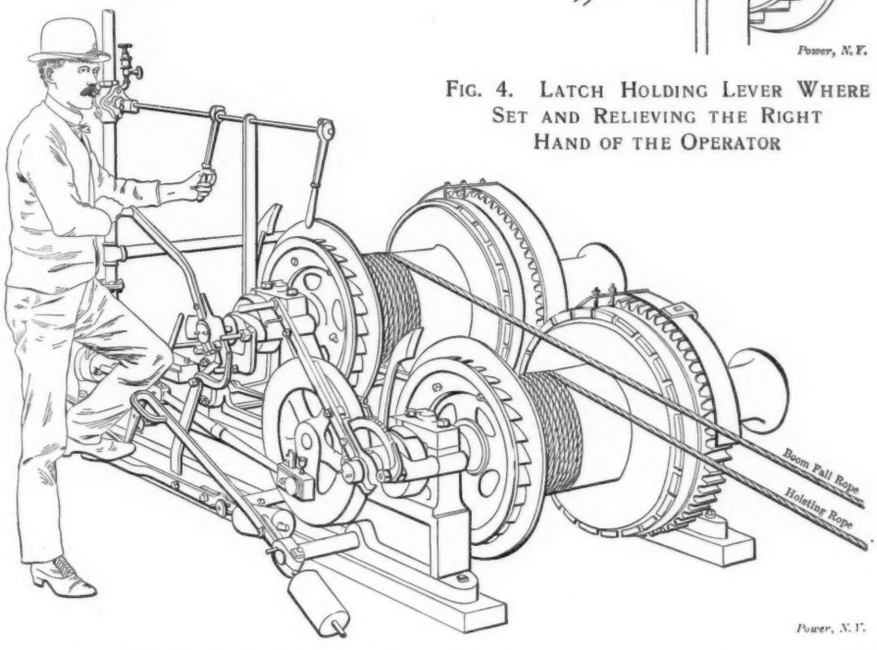


FIG. 3. OPERATING BOOM AND LOAD AT SAME TIME WITH SAFETY DEVICE IN USE

The object in using the two levers in combination for lowering is to guard against the possibility of the operator's foot slipping from the foot brake. In case that should happen, the boom can be controlled by the friction lever.

A precaution that should always be observed is to be sure that the safety lever is locked into the foot brake and the pawl applied whenever the boom drum is not in use.

This safety-lever lock is a valuable feature in the instance of a large springy boom, especially where rocks are to be handled after blasting, where there is no knowing whether the rock to be hoisted is free or not. When the engine is started, the boom will spring, and if the chain breaks, or the dogs fly loose, which frequently happens, the boom will spring back to its original position, and in so doing slacken for an instant the boom fall rope, which may throw out the pawl and cause the boom to fall. With the Lidgerwood lever-locking device, shown in Fig. 5, such an accident cannot possibly occur.

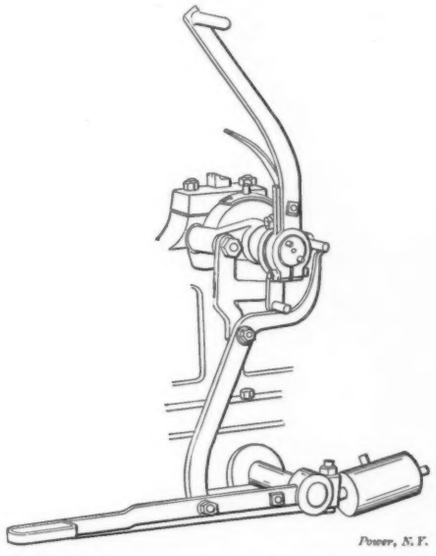


FIG. 5. LEVER LOCK ON FOOT BRAKE OF BOOM-FALL DRUM

Engine Designed for Superheated Steam*

BY R. W. ROGERS

An engine especially built to use superheated steam has been designed by Prof. J. Stumpf, of Charlottenburg Technical University, that bids fair to bring the matter to a solution. To avoid the difficulties attending the passing of steam through one valve, the incoming and outgoing steam move in the same direction, as is shown in Fig. 1.

EXHAUST

The compression period, 93 per cent. of the stroke, is attained in a very simple way, by utilizing the piston as an exhaust valve. In this way the piston acts as a valve and the crank as an eccentric. A small clearance, 2 per cent., is obtained by doing away with the exhaust valve and placing the inlet valves on the top of the cylinder. This construction also has another advantage; namely, that the incoming steam is enabled to highly heat the cylinder head before it is admitted and is admitted into a fairly large space shortly before the inlet valve is opened.

OPERATION

The working of the engine is as follows: The superheated steam is admitted at *A*, Fig. 1, and passes in through the inlet valve. The engine works on an early cutoff and the velocity of the steam at admission must be at least one-half the piston speed. After admission the steam expands and is exhausted through the exhaust passage without changing its direction of flow.

As the exhaust passage is directly connected with the condenser, that part of the cylinder in contact with the long piston is protected by a steam jacket.

The exhaust is only open one-fifth of the stroke period, so that the piston is cooled less than in the ordinary engine. The compression, which goes to nearly the admission pressure, causes a high superheating of the steam on admission that is increased by the heat from the steam jacket. In this way the walls and space where the steam is admitted are preheated.

ECONOMY

Naturally an engine that works under these conditions should have an economical steam consumption and this has proven to be the case, by test. A 500-

*From an article by Chief Engineer E. Rösler, in *Zeitschrift des Vereins Deutscher Ingenieure.*

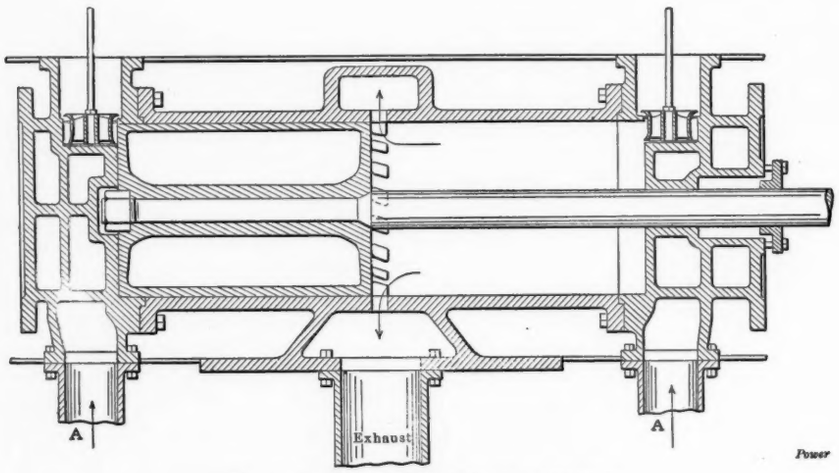


FIG. 1. SECTIONAL VIEW OF CYLINDER

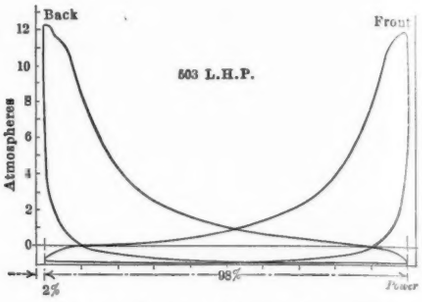


FIG. 2. DIAGRAM FROM ENGINE

horsepower engine of this type was recently tested in Mülhausen and gave a steam consumption of 10.12 pounds per indicated horsepower. Fig. 2 shows a diagram taken from this engine.

INLET VALVES

The inlet valves are operated on one rod that runs through the valves and operates the poppet valve by means of a simple lever. The motion to the valve-operating rod is derived from a swing arm that is operated by a simple eccentric on the main shaft. The engine is governed by a simple shaft governor.

The piston-rod stuffing box is the only place requiring metallic packing. The vacuum does not have to be as high as ordinarily used on compound engines. The engine is fully protected by patents.

Test of Steam Driven Pumping Plant

BY H. S. KNOWLTON

The pumping stations of the Metropolitan Water and Sewerage Board in the Boston district of Massachusetts have always been of interest to steam engineers on account of the care with which the equipment has been designed for the anticipated service and the economical operation which has been secured, particularly at the Chestnut Hill station. Architecturally, the stations of this Board are notably attractive, adding appreciably to the beauty of their surroundings and proving that even structures built for power production need not be in the least objectionable to the most critical landscape gardener.

The Arlington station of the Metropolitan Water and Sewerage Board exemplifies the board policies of design found in previously built stations, and a recent group of tests illustrate the economies to be anticipated in a water-pumping plant of well organized design and moderate capacity.

There are two engines at this plant: one a Blake-Knowles unit, and the other an Allis-Chalmers unit. The Blake-Knowles unit is of the horizontal duplex, compound-condensing direct-acting type, without side-packed plungers. The steam cylinders are 11 and 22 inches in diameter and are jacketed on both heads and barrels. The pump plungers are 12 inches in diameter, and both steam pistons and water plungers have a stroke of 18 inches. There is a Worthington condenser in the suction main near the engine, with 250 square feet of cooling surface, and connected with the exhaust-steam pipes a feed-water heater of 26 square feet heating surface. The condensation is pumped by an independent air pump of the Blake single-acting horizontal type, with 5½ and 8 by 7-inch cylinders.

The water pumped at this station is taken under pressure from a 20-inch low-service main, and the pressure on the suction side of the pumps is about 23.5 pounds. The contract for the Blake-Knowles engine required a capacity of 1,500,000 gallons in 24 hours, with a maximum piston speed of 95 feet per minute. The duty guaranteed was 50,000,000 foot-pounds per 1000 pounds of steam, when pumping against a total head of 290 feet, with a maximum steam pressure of 125 pounds per square inch. The final test on the engine gave the following results:

Duration of trial, hr.	24
Av. head pumped against, ft.	290.12
Plunger speed, ft. per min.	95.825
Total quantity pumped (by plunger displacement), gal.	1,578,865
Total quantity pumped (by Venturi measurement), gal.	1,551,400
Steam used by engine, jackets and air pump, lb.	62,853.5
Duty per 1000 lb. dry steam, ft.-lb.	60,727,400
Duty per 100 lb. moist coal, ft.-lb.	52,122,480
Evaporation of boiler per pound moist coal, from and at 212 deg. F., lb.	9.821

The Allis-Chalmers engine was erected in 1907, but the final official duty trials were not made until January, 1909. This engine has been in almost constant use during the past year. It is of the cross-compound flywheel type, fitted with Corliss valve gear and operates two horizontal outside-packed plunger pumps. The high- and low-pressure steam pistons are 14 and 28 inches in diameter, respectively, and the pump plungers 8½ inches in diameter, all having a stroke of 18 inches. The contract requirements were a capacity of 1,500,000 gallons in 24 hours, when operated at a plunger speed of 195 feet per minute against a head of 290 feet; and when operated at that rate should show a duty of 120,000,000 foot-pounds per 1000 pounds of dry steam; also that when pumping at the rate of 750,000 gallons in 24 hours the engine should show a duty of 110,000,000 foot-pounds per 1000 pounds of steam at 125 pounds per square inch. The results were:

ONE-HALF CAPACITY TRIAL, DEC. 31, 1908, TO JAN. 1, 1909.

Duration of trial, hr.	24
Av. head pumped against, ft.	290.11
Plunger speed, ft. per min.	95.905
Total quantity pumped (by plunger displacement), gal.	771,360
Total quantity pumped (by Venturi measurement), gal.	763,525
Steam used by engine, jackets and air pumps, lb.	17,671
Duty per 1000 pounds of dry steam, ft.-lb.	106,742,470

FULL CAPACITY TRIAL, JAN. 6 AND 7, 1909.

Duration of trial, hr.	24
Av. head pumped against, ft.	290.3
Plunger speed, ft. per min.	191.346
Total quantity pumped (by plunger displacement), gal.	1,538,977
Total quantity pumped (by Venturi measurement), gal.	1,530,986
Steam used by engine, jackets and air pump, lb.	32,475
Duty per 1000 pounds dry steam, ft.-lb.	115,959,370
Duty per 100 pounds moist coal, ft.-lb.	90,025,832
Evaporation of boiler per pound moist coal from and at 212 deg. F., lb.	9.77

Although the engine is satisfactory for the service, there was deducted a forfeit

of about $1460 from the contract price on account of the duty falling below the guarantee.

The principal items of cost for this station, exclusive of engineering, are as follows:

Building, including chimney and engine and boiler foundations	$33,208
Engines	14,233
Boilers and setting	6,156
Piping for engines, boilers, heating, etc.	2,859
Railroad side track	841
Miscellaneous, including grading, suction and delivery pipe laying, etc.	3,111
Total	$60,408

The contracts under which bituminous coal has been purchased during the year for the Metropolitan service, have specified that the coal furnished should contain approximately 14,200 B.t.u., 18 to 20 per cent. volatile matter, 8 per cent. ash and 1 per cent. sulphur. Coal, which when dry contains more than 14 per cent. ash, 23 per cent. volatile matter or 1.75 per cent. sulphur, is subject to rejection. Payments are made on the basis of a price bid, corrected for variation in the heating value and percentage of ash as determined by samples of the coal delivered, an addition being made when the number of B.t.u. exceeds 14,200 and a deduction when the number falls below 14,000, or the amount of ash exceeds 9 per cent. The average results of the tests of bituminous coal are given in the following table, including coal purchased for both water and sewerage work:

Kind of Coal.	No. Samples Tested.	British Thermal Units.	Per Cent. Volatile Matter.	Per Cent. Ash.
Barnet	60	13,931	15.67	9.97
Carbon	3	14,088	17.03	8.84
Vulcan	39	14,443	20.14	7.04
Davis	81	14,172	21.43	7.94
Georges Creek	5	14,039	18.67	8.64

A Small Duplex Pump Gives Trouble

BY F. M. WILLIAMS

"If pump is not made satisfactory before Monday morning, September 27, it will be replaced by another machine and will be held here subject to your orders. Answer quick."

Thus ran a telegram received in the office of a pump-manufacturing establishment recently. While the transaction involved but a small duplex pump for boiler feeding, the manufacturers were loath to accept the "black eye" which would ensue on their machine being rejected, and especially in view of the fact that their records showed the machine in question to have been tested in the shop with great severity and to have withstood all tests with unusual facility, and so a "doctor" was despatched to the scene of trouble with instructions to "fix it."

On presenting his card to the superintendent of the establishment in which the recreant pump was located, the troubleman was advised that his presence was superfluous. The pump was simply of no use and would be displaced without further delay.

"Well, may I take a look at it?" asked he.

"Yes, if it will do you any good," replied the superintendent, "but the pump has already been gone over by two good pump men, and they both condemn it as not having proper-sized steam cylinders for the work, so I tell you beforehand that you are only wasting time."

"I have come a long way to see your pump, and I feel sure I can make it go. I can't go home and tell my people that I came out here and returned without seeing the pump, so with your permission I will look it over."

With a final "All right, but it will be useless," the superintendent led the way to where the pump stood by the side of and connected up with, and in the same way, a slightly smaller pump of different manufacture, which was pounding along lustily. The "doctor's" glance took in all the details and for a moment he was nonplussed.

"May I start it up?" he then asked.

"Yes, I guess you can start it up, but it won't go long;" and so it proved. After a few strokes, gradually decreasing in length, the pump came to a dead stop with a shiver and a groan. The pump man began to look interested.

"May I take your Stillson a few minutes?" asked the "doctor" of the engineer, who had become an interested observer. On the acquisition of the wrench the valve at *A* (see Fig. 1) was screwed tightly shut and the plug in the tee at *B* removed. Admission of steam to the pump was followed by a deluge of water through the open tee end. The pump being stopped, the valve *A* was slowly opened by the pump man, whose expression now resembled a grin and, as he expected, there resulted but a slow trickle of water from the open tee, although No. 1 pump was running at full speed.

On asking permission of the superintendent, who had been standing by in silence, to shut No. 1 pump for a short while, it was readily granted. The valve *C* was then closed, the boilers being fed by the injectors meanwhile, and the bonnet taken off of *A*. The result justified the doctor in his hasty diagnosis and incidentally caused the superintendent to deliver a brief and eloquent opinion on engineers in general and himself in particular. The humor of the situation, from the pump man's view, was enhanced by the superintendent's declaration that he had thought the trouble might be in the piping, and so had had the original piping all removed and new piping installed. Unfortunately only a superficial examination was made of the valves, which were reused. To all outside appearances the valve *A* opened and closed as smoothly and properly as any other. Fig. 2 shows what had happened to the valve *A*.

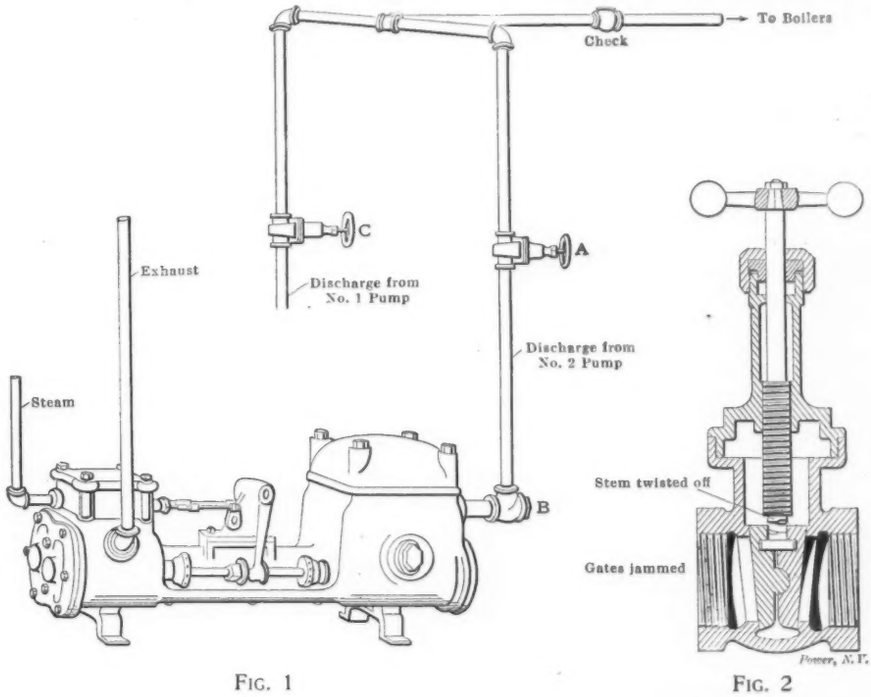


FIG. 1

FIG. 2

ELECTRICAL DEPARTMENT

Especially conducted to be of Interest and Service to men in charge of Electrical equipment.

Some Interesting Failures of Electrical Machinery

By J. H. Seager

Having regard to the considerable number of chances which the construction of an electric motor necessarily involves for the breakdown of the machine, either mechanically or electrically, it is astonishing that in spite of the rough conditions of usage which very often obtain in connection with motor-driven machinery the proportion of breakdowns in such plant is comparatively low. It is, however, true that a motor-driven manufacturing plant seems to be subject to various classes of breakdowns peculiar to itself and which do not extend either to stationary apparatus, such as transformers and switchgear, or machinery driven otherwise than by motors, and it may be interesting, therefore, to give a few examples of the way in which motor-driven machinery has broken down, in order to indicate some of the points for which the man in charge of such plant must be on the look out.

One of the greatest sources of trouble in electric motors is the penetration of foreign matter to the windings of the motor. A somewhat unusual case of this sort occurred in a destructor plant devoted to the burning of the domestic and trade refuse of a municipality. In this case the dust from the burnt refuse was allowed to blow about the yard in clouds, and this very seriously affected the working of the motor of a crane which was installed for handling the refuse. Not only did it penetrate into the windings of the motor itself, but it also affected the bearings of the machine and worked its way into the gear case. Until a more suitable remedy was found the attendant in charge of the crane was compelled several times during the day to blow the dust out of the motor and gear case with a large bellows, but signs of deterioration became so obtrusive and the risk of breakdown so obvious that eventually a corrugated-iron shelter had to be erected for the motor and gearing. This was not, of course, quite dustproof, as an aperture had to be left for the control lever, but a considerable step in advance had been made in the direction of keeping the working parts free from dust.

Another enemy of the electric motor is, curiously enough, its serviceability. The motor is usually constructed to carry overloads up to 25 per cent., or even 50 per cent. for longer or shorter periods, and it does so without interfering in any way with the performance of its work, excepting a slight lowering of speed and loss of efficiency. The readiness with which it does such work in some cases leads to abuse, and it is only natural that from time to time cases occur which point out to those concerned the inadvisability of working a willing horse to death. In one such instance, also occurring in a refuse-destructor plant, which was operated in connection with an electric generating station, a motor was used to operate an iron extractor for taking out the pieces of iron from the clinker extracted from the destructor cells. This motor was very liable to become tremendously overloaded and it was not considered necessary to put separate fuses upon its circuit. The trouble was thus transferred to the direct-current dynamo which supplied this power circuit, and as this, besides supplying the motors in and around the generating station, also excited the field winding of an alternator, there was opportunity for considerable trouble. On one occasion the extractor motor became overloaded about 100 per cent. owing to the passage of some very refractory lumps of clinker through the extractor. This very heavy current instead of blowing fuses in the motor circuit, as it would have done had there been any fuses there, caused the direct-current exciter to hunt very badly, with the result that there was a considerable variation of the station voltage. The installation of fuses of sufficient capacity to carry ordinary excess loads, but to prevent any such unreasonable overloads as described above, cured the trouble.

An induction motor was used for driving the air pump in connection with a main generator engine in an electrical power station. At one end of its shaft it had a short-circuiting switching device; when the motor was running normally the starting switch was on its "off" stop, and the effect of pulling out the short-circuiting switch was to stop the motor. The rotor of this machine, however, had a rather excessive amount of end play, and after some hours of running this motion jerked the short-circuiting switch out, with the result that the motor stopped. Of course, the engine lost its vacuum and slowed down considerably, with the result that the electrical pressure upon the distribution system dropped below normal. Fortunately, the attendant in charge was able to locate the trouble very quickly, and the switch was reinserted in about one minute after the occurrence, the supply pressure then building up as soon as the condenser restored the vacuum.

Rotary converters used on widely extended systems are subject to high voltage on their high-tension side, and when the voltage of the direct-current side is likewise high, they have a habit of grounding their slip rings. This is very often due to a surge on the alternating-current system, which may be caused by a disturbance at another transformer substation, due, for example, to a heavy circuit-breaker coming into action. In a system of this description it was discovered that the best way to minimize such surging was to run the rotary converter light on the polyphase side only, that is to say, without any load on the direct-current side. This tended to steady the voltage on the supply system and to neutralize the effect of any surges. If, owing to exceptional conditions, any machine should break down it was usually the one which was running light and this was preferable from the point of view of maintaining the supply of power on the direct-current side of the system. Another point which it was found well to watch carefully in connection with these machines was that the slip rings had to

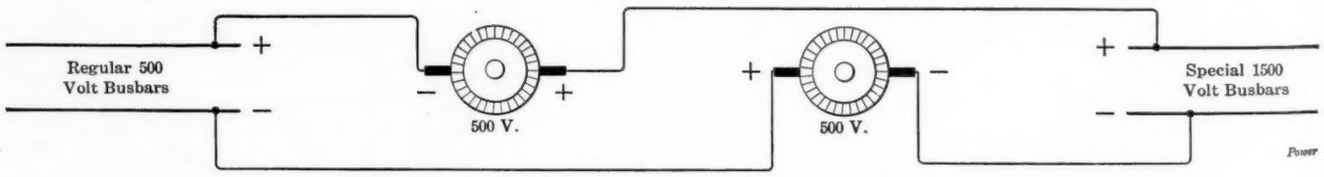


Fig. 1. Elementary Diagram of Main Generator Connections

be kept extremely clean. Any dirt on the slip rings has a very great tendency toward inducing the machine to flash over.

A rather unusual form of breakdown occurred with a medium-capacity direct-current multipolar machine. This particular machine worked on a 500-volt, three-wire system, and it was also used on a 1500-volt system, two generators being used as boosters, one on each side of the station busbars, as represented diagrammatically in Fig. 1. This provision was made in order to give a supply at a considerable distance at a higher

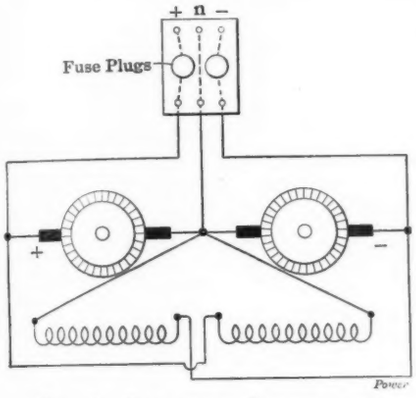


FIG. 2. BALANCER CONNECTIONS

voltage, in addition to the local power supply at 500 volts, and in order to meet this high-voltage condition the machines were specially heavily insulated. Trouble, however, arose owing to the shunt-field circuit of one of the machines being broken accidentally. The machine had been speeded up in order to have the commutator cleaned, and as it was a shunt-wound dynamo, it had excited itself unnoticed by the man in charge of the operation. This man broke the shunt circuit by lifting the brushes, and the inductive kick was sufficient to break down the insulation of the field-magnet coils, causing a burnout. The machine was then tested and two damaged bushings were found at the field-magnet leads. These were then replaced and the machine was again tested. A most remarkable result was then obtained: the dynamo showed an insulation resistance of about 100 megohms, whereas it usually tested out at about 20 megohms, and the uncommonly good result made the engineer in charge of the plant suspicious as to the availability of the machine for running purposes. In order to try the machine, however, it was placed on the 500-volt supply system with light fuses, and it ran at this pressure perfectly, there being no sign of damage. It was then put on the 1500-volt system, retaining the light fuses, and the armature at once became grounded in four places. In order to prevent a recurrence of such an incident, after the machine was repaired it was arranged that it should be excited from a separate circuit.

There was a rather interesting case of breakdown in connection with a balancer set. This machine developed a small flat on one of its commutators, due probably to one of the bars being of rather softer metal than the rest, and it was decided to run the set from one side only, using that half as a motor, and to leave the other half "dead" while its commutator was being trued up. The machine was usually supplied with current through two plugs, one on the positive and one on the negative, as shown in Fig. 2. One of these was taken out and the starting switch put in. It was, however, forgotten for the moment that in order to improve the balancing effect on the system the shunt windings of the machine were cross-connected, and, therefore, there was no field with this arrangement on the machine which had the current going through the armature, the field being developed upon that half of the set which was to have been run light. The result was, of course, that a very heavy excess current passed through the armature which had been connected in circuit and the starting resistance burned out. This experience taught the lesson that whenever it was desired to true up the commutator of one machine of the set driving it by the other member, it was necessary to change over the field connections of the two machines.

An Unnecessary Mishap in an Isolated Plant

BY RULOF KLEIN

Spending a "week-end" at the house of a farmer friend last summer, I stumbled on a bit of oil-engine experience. When I arrived on Saturday afternoon, I was informed that a barn dance was arranged for that night and was taken to the handsomely decorated barn. Noticing a great many electric-light bulbs among the greens and flowers, I inquired about the source of current. Like most other things around the place it was "homemade," in the little power house shown in Fig. 2, engineered and built by the farmer's son. The wooden structure contains a 6x8-inch vertical single-acting oil engine, belted to a dynamo. The elevated barrel shown outside the house contains the cooling water for the cylinder jacket with which it is

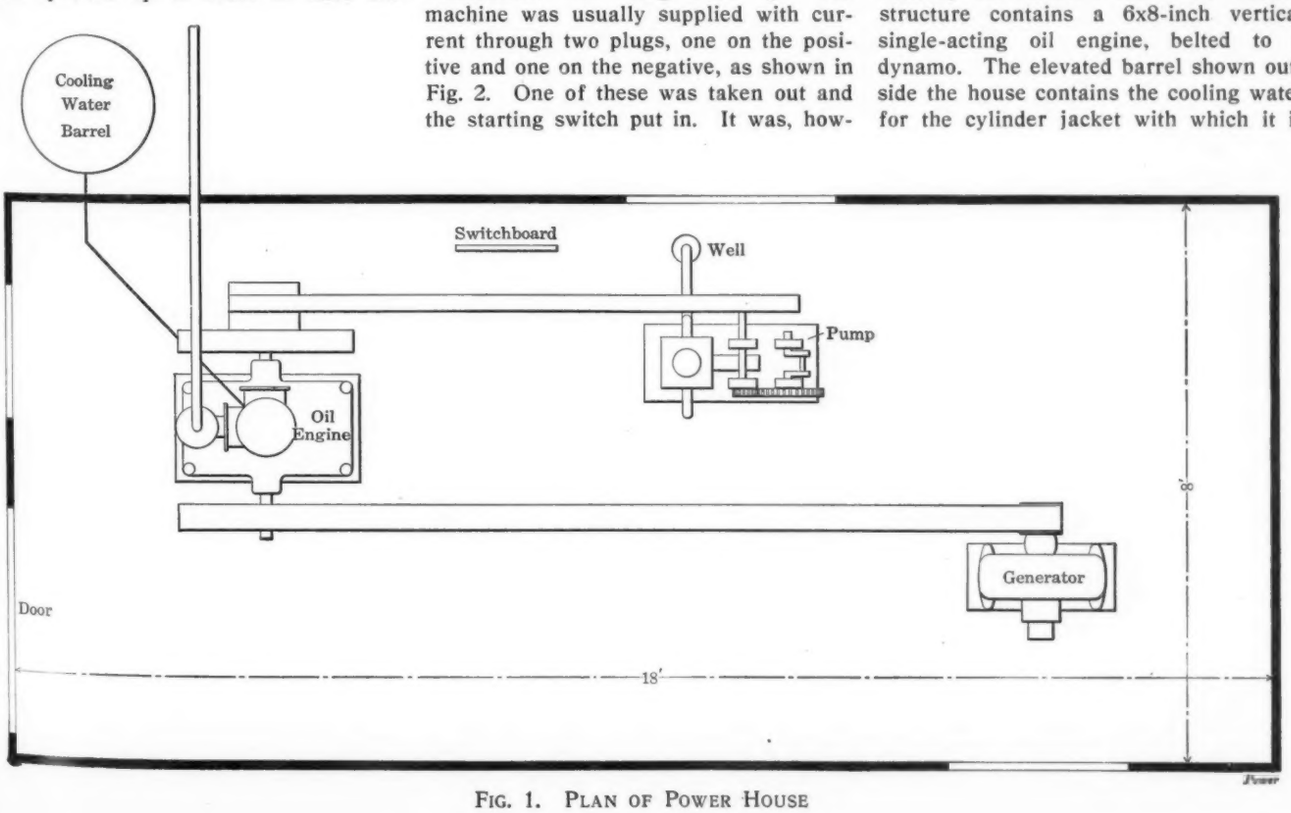


FIG. 1. PLAN OF POWER HOUSE

connected, as usual, by two pipes for circulation. The "plant" is provided with a nice little panel switchboard containing a main switch, two knife switches for the house and barn circuits, a field rheostat, a voltmeter, ammeter and a pilot lamp. The dynamo is an ordinary direct-current machine. Fig. 1 is a lay-out plan of the outfit.

This equipment was illuminating the barn that night and all went well until suddenly, between two dances, the lights began to grow dim and at last went out. I was on the lawn at the time and could hear the exhaust discharges grow weaker and weaker as the engine slowed down to a standstill; up to the last revolution every charge had been ignited. This sounded familiar to me and I ventured to suggest that the fuel supply must have given out, as the igniter, engine and generator had been operating all right up to the very last revolution. I was

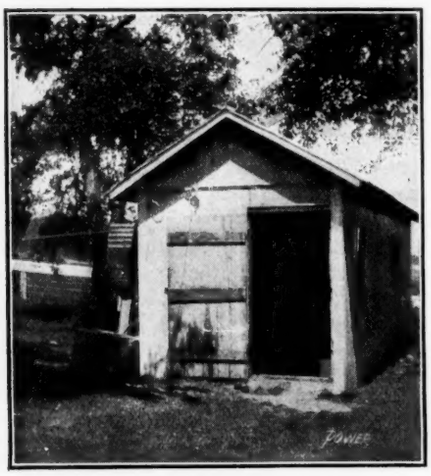


FIG. 2. SMALL ENGINE HOUSE

told, however, that before starting up orders had been given to the farmhand to fill the fuel tank, and that my diagnosis was therefore wrong. Nevertheless, an investigation showed that the tank was really empty. It was refilled and the engine started up again. I watched until the engine had regained full speed. The belt was so slack that it was dragging on the floor for a considerable distance between the pulleys. I called attention to this condition and to the danger of the belt jumping off, but was assured that the belt was loosened purposely in order to reduce friction. I suppose the friction in the bearings was meant, but the belt was causing more friction by dragging on the floor than could ever have been developed in the bearings.

The engine had been running for another half hour, when suddenly the lights went out again. This time it was found that the belt was wound up between engine flywheel and crank case, and it stuck there for the rest of the night, in spite of all attempts with crowbars to unravel it. Needless to say, this accident put a stop to the dance.

The next morning I was asked by the farmer's son to have a look at the engine; the expression of his face showed that he was in trouble. An "engineer" and his helper from a neighboring town had come down early to fix the engine. Their most important tools were a sledge, a machinist's hammer and a chisel. In trying to take the flywheel off the shaft, which seemed the only way to remove the belt, the chisel, used as a wedge, had been driven between the head of the key and the hub of the wheel by means of the sledge. The head had been broken off the key, after which the chisel had been driven between the cast-iron eccentric and the flywheel to force it from the shaft at the inside. The result was that the eccentric also had been broken and the flywheel driven tighter on the key. The belt was still around the shaft as tight as ever. At my suggestion the cylinder and crank case were dismantled. This loosened the belt and gave access to the inside of the keyway from which side the key was driven out. This was necessary anyhow because the flywheel had to be taken off the shaft to put on a new eccentric.

It was not until three weeks afterward that the engine was started up again. A good-sized bill from the "engineer" and great inconvenience to the guests and household were the price paid for the experience.

I was sorry for the youngster, as he deserved a great deal of credit for installing the outfit. The plan view in Fig. 2 shows that besides the generator, a pump is driven by the engine. It draws water from a well and delivers it to a tank under the roof of the house, from which the water is distributed throughout the domestic piping system. Although the plant might have been made more foolproof and efficient, it shows that isolated houses may be readily equipped with all modern conveniences at an investment which should be paid for by the service many times over. If necessary, a small refrigerating outfit could be added to the equipment of the plant.

A Canadian correspondent of the *Electrical World* says that within a radius of eight miles of Ottawa are undeveloped water powers amounting to 200,000 horsepower, and within a radius of 45 miles of the city the amount is estimated at 917,400 horsepower. Of this vast amount only 58,400 horsepower is at present in use. Just now electric power can be purchased for less than $15 per horsepower per annum, continuous service. A new company, which is seeking a charter from the city, has agreed to sell electrical energy at $11 per horsepower.

CORRESPONDENCE

Case for a "Soft" Coupling?

In the power plant of a large apartment house there is a centrifugal pump direct coupled to an electric motor by means of two flanges through which there are four bolts. Ever since this pump was put in operation there has been trouble due to the buzzing or purring of the motor being transmitted to the pump, and thence throughout the discharge pipe, which rises through every floor (the house is about 16 stories high) to a tank on the roof. Can anyone suggest a remedy for the trouble?

WILLIAM J. O'DONNELL.

New York City.

Repairing Holes in Commutators

While the following probably is not new to many, yet I am sure that large numbers of engineers are not familiar with the expedient and it has helped me so many times that I feel that everyone handling electric machinery should know it.

When burnt places appear in the mica between commutator bars, carefully clean out all of the burnt mica. It is important that the cleaning be done thoroughly and a handy tool for this purpose can be made by grinding a piece of hack-saw blade to a long sharp point. The burnt place should be scraped with this tool until the remaining mica appears hard and white. Then make a thick paste by moistening litharge with glycerin, as stiff as it can be made. Pack the hole in the commutator with this paste, taking pains to work it into every crevice, but do not attempt to smooth the surface until the paste has had a few hours in which to harden. The machine should not be run for three or four hours after applying the paste. I have used this with success on 500-volt direct-current machines and on the rectifying commutator of a 2300-volt alternator.

The litharge and glycerin can be purchased at any drug store and five cents worth of each will be more than enough. It is most important to get the old burnt mica all cleaned out of the hole and one should not be afraid of making the hole larger so long as he gets it clean and lets the paste set thoroughly before running the machine.

G. E. MILES.

Denver, Colo.

The first steam-turbine locomotive was recently completed and tested by the North British Locomotive Company, and proved very successful.

GAS·POWER·DEPARTMENT

Everything worth while in the Gas Engine and Producer Industry will be treated here for the use of practical men

Control of Water Feed to a Gas Producer*

By Frank P. Peterson

We have come, quite justifiably, to fear backfiring by the gas engine as one of its most malignant and elusive ills. Very plausibly, backfiring may be said to be due to engine derangement, for which no directly traceable responsibility rests on the gas producer, but I expect to show that the gas producer must be made to bear its very considerable share in the establishment of the first causes involving the evil.

Of degrees of importance ranging about in their order of presentation, the following are the fundamental causes of backfiring by a gas engine: (1) pockets and projections in the combustion chamber, (2) lean or excessively rich mixtures of air and fuel, (3) deranged ignition, (4) the use of excessive amount of lubricant or lubricant of poor grade. Of these, the first, the third and the fourth have no relation whatever to the producer, and the second may have connection directly with the producer or through one or all of the other three, or through the method of governing in a measure varying about as the ability of the producer to deliver gas regularly which is fairly constant in quality. Correct such of these objectionable conditions as may exist, and you have eliminated the reasonable probability of any backfiring or premature ignition by an engine operating on producer gas, assuming, of course, that the compression is what it should be.

For this backfiring evil a multitude of "cures" have cropped out, chief among which is the demand for regulation or removal of hydrogen as a constituent of producer gas. The reason for this certainly seems obscure when we seek to connect it with any rational evidence in the operation of an engine. An offspring, nevertheless, of this suggestion, has come to the surface in the form of the supposed necessity for the control and definite measurement of the ratio of steam to air in the draft supporting combustion.

Without in any degree desiring to criticize the several methods and appliances, many of them ingenious, which have been designed for the purpose of automatically controlling the proportion of steam to be admitted along with the air for combustion in producers, it may be said that the greater number of these fail of their purpose in practical application. They are all more or less delicate in structure, notably in the use of knife edges to obtain sensitiveness. We have only to consider the working conditions in the producer room to foresee the effect of floating dust and ashes, not to mention the corrosive action of sulphurous fumes, often released through the poke holes at the time of cleaning an idle producer, upon such mechanisms.

Delicately balanced overflow provisions cannot be maintained in perfect working adjustment without almost constant attention, because water cannot always be provided which is free from impurities that attack or collect upon the gates or orifices which determine the quantity of water delivered to the vaporizer.

Diaphragm-controlled needle valves have presented a seemingly simple solution of the water-regulating problem where flash-type vaporizers are to be used, but even these are found liable to the breakage of the flexible fabric at the edges where the diaphragm must be gripped. The pressures available for operating the diaphragm are relatively low and the areas must be correspondingly large in order to secure positive and sensitive response to pressure variations, and every man whose experience includes the operation of gasolene engines knows the persistent perversity of a needle valve whenever any solid matter passes it. But the needle valve is one of the safest and most positive means to be found in use with the flash type of vaporizer.

Because of all these difficulties involved in the employment of means to control automatically the delivery of water to a producer, and in view of the questionable gain to be effected as a whole, I have decided to drop the idea, and I have not yet had reason to think that I made a mistake. I am not alone in holding this opinion. P. W. Robson, a well known English producer designer, is of the same mind, and so are other experienced men. Mr. Robson thinks that the idea that automatic control is necessary is due to the difficulties which are sometimes experienced in working on a widely fluctuating load. For instance, if a plant with a flash vaporizer has been working for some time on full load, so that the temperature of the fire is maximum, and the load is then suddenly taken off, two conditions seem to follow; if the water feed to the vaporizer continues at the former rate suitable for full load, an excess of steam in proportion to air will be made until the vaporizer is cooled down, and this steam passing through the hot fire (which has been left at the maximum temperature attained while the engine was running at full load) will cause water gas to be produced for a short period afterward, and when this comes through to the engine, the gas valves of which are adjusted for the ordinary conditions, excessive explosion pressures will be produced in the working cylinder; secondly, the excessive steam will have the effect of unduly cooling the fire, so that if a full-load demand should be made on the producer shortly afterward it will be unable to meet it, with the result that the engine will tend to stop. Mr. Robson has found, however, that the production of water gas under such conditions is due far more to the reduced velocity of the saturated air passing through the fire when the load is reduced than to the unchanged rate of water feed to the vaporizer; he says that even when the water is entirely shut off simultaneously with the removal of the load, the water gas is produced to practically the same extent as before.

When the plant is called upon to meet a large increase of load, Mr. Robson finds that the automatic regulation of the water feed does not help matters at all. If the steam supply is made automatic with the suction strokes of the engine, as soon as the load comes on and before the fire has been brought into a good condition the maximum water supply will be drawn in, and the regulation is no better than that obtained with a constant feed adjusted to suit the average load.

Mr. Robson has stated this contention with a clearness upon which I am unable to improve. I might add, however, that with a throttling type of governor the initial volume to be compressed is so low as to prevent even the "excessive explosion pressures" which seem to be so feared. Since these do not prevail, the only disadvantage is the fuel waste due to the momentary derangement of the mixture, and this is scarcely worth serious concern, since the condition in which it will occur is infrequent and is by no means dangerous, even when the engine is governed on the hit-and-miss principle.

While hydrogen has been made the producer scape goat, carbon dioxide is the real offender. The fact that excess steam in the producer causes the pro-

*Abstract of a paper read recently before the National Gas and Gasolene Engine Trades Association.

duction of high hydrogen content has apparently obscured the correlated fact that excessive CO_2 will be found with any considerable preponderance of hydrogen; consequently, the hydrogen factor is condemned for the company in which it is found.

The simple means required for measurement of the carbon dioxide content of producer gas makes such determinations easy for every operating engineer, and the reward will be a definite knowledge of the critical limits to which his gas may vary without causing troubles in his engine, chief among which is backfiring due to such a dilution of the mixture as will retard combustion sufficiently to hold flame in the cylinder from cycle to cycle. The recording type of CO_2 gage now used in steam plants is ideal for the purpose and should become a part of every extensive producer installation.

Carbon dioxide is present in all fixed fuel gases except natural gas. In producer gas the unavoidable extent of its presence will depend jointly upon the skill with which the producer is designed and the character of fuel used. The fundamental details contributing most largely to its production are insufficient area of fuel bed for the volume of gas demanded; insufficient steam in the draft, and improper relation between the areas for conducting the draft into the fuel bed and the gas out of the generator. Even with a properly designed producer, excessive CO_2 may easily be formed by slovenly methods of handling the producer, neglect and, on the other hand, a lack of knowledge of when to let it alone.

How Fischer Almost Got a Spark

By George H. Wallace

The multitude of petty troubles which usually accompany and hoodoo the average gasolene engine are the things which test a man's ingenuity and self-control. Not the least of these troubles are those occurring in the ignition system. If there is trouble with the sparking arrangement it may be any one of several dozen different things, or an almost endless combination of them, none of which it is necessary to mention here; in the instance here related it was lucky for the community at large that the desired spark was not obtained.

The Reliable Gas Engine Company had furnished an engine of about 20 horsepower to supply the necessary "go" for a stone-crushing and screening plant, at a quarry about five miles from the factory. One day the engine gave a bang and a few asthmatic gasps and stopped. An inspection showed a broken crank shaft, and the frame split downward through the main bearing. They telephoned to the factory for help and a man named Fischer was sent out to investigate and fix up the damage.

Fischer went out and held an inquest over the remains and decided that he could bring the corpse to life and make it as good as new by putting in a new shaft and strapping up the frame. Accordingly, by means of a couple of shrink bolts, a few pieces of boiler iron and tap bolts, the frame was toggled up, the new shaft put in and the engine got ready to start.

Early on the day when the start was to be made, a freckled boy drove up to the door of the shed which served as the "power house" and deposited on the floor inside the door an oblong box with considerable noise and carelessness. Fischer merely glanced at the operation and went on with his work. At noon, after eating his lunch, he lighted his pipe and sat on the box near the door to blow smoke rings and build air castles. Just then the superintendent of the stone company came in to note the progress made and he and Fischer joined in a pleasant conversation. Finally the superintendent went over to "size up" the engine at close range, while Fischer proceeded to fire up again. Placing the pipe in his mouth he got out a match and scratched it on the side of the box. The superintendent looked up just in time to see and hear the "s s-s-sk-skr-r-r- ratch" of the match on the oblong box and with a cry of horror shot out of the door past the astonished Fischer and jumped over the railing to the ground 8 feet below in preference to going down the stairs beside the building.

Gathering himself together he ran for the protection of a neighboring ledge, shouting a warning to all within hearing to do likewise. Peeping around the corner of the ledge he implored Fischer to come out quick, but Fischer only leaned calmly up against the door jamb and smoked in peace, meanwhile wondering if the superintendent had gone batty.

The superintendent finally enjoyed the same experience as does the fanatic who predicts a grand wind up for the earth on a certain day and finds out he has miscalculated the schedule time. He sneaked back to the "power house," wiped the sweat off his face and exclaimed: "Fischer why in —— didn't you run?"

"What for?" asked Fischer; "I didn't see anybody or anything to run from. What's the matter with you anyway?"

"Say!" said the superintendent, as he pointed to the box on which Fischer had scratched the match, "D'ye know what's in that box?"

"I do not," said Fischer, "and care less," but he flinched a little as he glanced at the box on which appeared in large letters:

GIANT BLASTING POWDER.

Gas Engine Tuberculosis

By H. K. Wilson

In reading scientific literature, we learn that tuberculosis occurs in many parts of the human body, but for the sake of comparison we will consider the lungs alone, as the gas engine and human lungs show more points of similarity. Broadly, tuberculosis signifies the wasting away of the lung tissues. This may be brought about by breathing impure air, and by inhaling disease germs and particles of dust, metals and other foreign matter. These poison and clog the passages of the lungs, causing decay that can only result in death unless arrested in the early stages.

Now take up the gas-engine side of the comparison. How often do we find engines located where they must breathe the gases from a forge, ammonia gas from leaking cold-storage machines, or gases from various chemical reactions which take place in different industrial plants? Few people stop to consider that oxygen is as essential to the gas engine as it is to the human being, although a stray microbe may cause no fear of a quarantine. Another curse which is thrust upon the gas engine through ignorance is that of insufficient air supply. Stop and think of the engines that are running in almost air-tight rooms, gasping for air and getting only an increased charge of fuel with a resulting poor mixture.

Two examples of such abuses have been brought forcibly to my attention. In one case, I found an engine operating in a basement in connection with a small cold-storage plant belonging to a market. At the time of my visit the engine was operating irregularly. The old-style flame igniter was in use and the flame was yellow and smoky. The ammonia in the room was so strong that a person could stay there but a few moments, and yet the engine was doing fair work. How strong must the gas have been at the level of the engine's intake? This neglected engine was cursed for weeks and then thrown out as unreliable, giving way to an electric motor. Had this engine had the benefit of more brains and less ammonia, the owner's pocketbook would have been much better off at the present time and there would have been one less undeserved discredit against gas power.

At one time I had charge of a pumping station containing two 25-horsepower oil engines. They were arranged to take their air supply from inside of the building and running at their regular speed used about 140 cubic feet of air a minute each. It was always necessary to have a window or door open, or else the air pressure would be so low that the draft through the stove would be

reversed, bringing coal gas and ashes into the room. These engines were of the "quality"-governing type; if the speed dropped, more oil was admitted. If the reduction of speed was due to shortage of air, more oil was used and wasted in imperfect combustion, with the result that the cost of operation was increased with no returns.

In the cases cited, the engines were working at a disadvantage, with unnecessary wear and showing an excess in fuel cost that would have much more than paid for the cost of proper air connections.

As a salesman and repairman, I have seen many engines running without any protection from dust, etc. In blacksmith's shops, for example, where the engine was 4 or 5 feet from a forge, with ashes and dust floating through the air to enter the bearings and cylinder and cause rapidly increasing wear. In many machine shops, one will find a gas engine and an emery wheel close neighbors, and yet one would expect to find machinists gifted with more intelligence. Wood-working shops are not quite as hard on the engine as fine sawdust will not cause so much wear on the bearings, but when it is drawn into the cylinder, it cannot avoid gumming the valves and interfering with their operation. And after it has passed the valves it is burned, and the ash can cause untold wear, beside making a deposit on the cylinder walls which may be the cause of a broken crank shaft or connecting rod from preignition. I have been in places where so much dust and dirt was deposited in the engine that one could hear the piston grind against the walls of the cylinder.

The analogy between this sort of treatment and the causes of human tuberculosis, while crude, is evident, and the results are just as destructive in the one case as in the other.

LETTERS

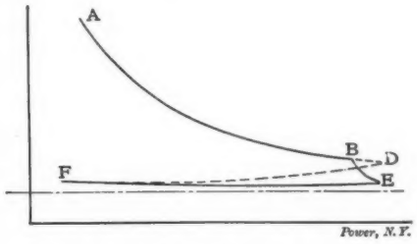
Gas Engine Valve Setting and Indicator Diagrams

I hereby bare my head and bow my acknowledgments to Mr. Eyerman, not only for the gas-engine diagrams shown in the October 19 issue of POWER, but for a set of indicator diagrams that really mean something.

Is it reasonable to suppose that a man who is unable to set the valves on his engine, aproximately correct, "by the eye," can attach and correctly adjust an indicator and its reducing motion? If not, and there are geometrical inaccuracies present, of what value are the "diagrams" he takes?

Some sixteen years ago I bumped into my first wavy line on an indicator diagram, and not being able to figure out the whyness therefor, I took the matter up with the designer of the engine, who, I believed, was up on that sort of work. His reply was as follows:

"The cards sent seem very fair indeed, and if the engine runs smoothly do not think it worth while to try to improve it. The wavy line of the 11x12 cards is often met with; it is caused by a flutter or vibration of the indicator pencil, caused by a sudden change of position. You will see the same thing by pulling the indicator pencil up and letting it go suddenly, when it will vibrate like a tuning fork. The vibrations are very rapid; on the cards you send they are



GAS-ENGINE INDICATOR DIAGRAM

something like 60 per second. They will always be (with the same indicator and spring) made in the same time; you can prove this on a card by drawing lines from the high parts of the waves to points on a circle whose diameter is the length of the card, as in the sketch, which will show that the flywheel goes through the same angle for one vibration that it does for the others. The true line can be drawn midway through the waves.

Very truly yours,

E. J. ARMSTRONG."

I trust that Mr. Armstrong's explanation will satisfy Mr. Buschman that the apparent partial vacuum shown in Mr. Eyerman's cards Nos. 10, 11 and 12 is merely an overtravel of the indicator pencil due to the inertia of the moving parts of the instrument. And if, as Mr. Armstrong says, the true line is midway of the high points of the waves, the exhaust line in Mr. Eyerman's diagrams would come slightly above the atmospheric line, which is just as it should be.

I do not question Mr. Buschman's veracity when he says he has seen a number of diagrams "exactly like the one" he shows on page 327. But I do deny that he ever saw such a diagram that gave a correct delineation of the events in the cylinder of an internal-combustion reciprocating engine, for the following reasons:

At the point of exhaust opening his diagram indicates that the pressure commences to drop through a curve nearly at right angles to the expansion curve—which action may be likened to that order for material that concluded with "Please deliver these goods yesterday." But after making this impossible start, the imprisoned gases seem to have thought better of it and *slow up* as the exhaust valve *opens wider*. This means, in Mr. Buschman's practice, nothing more nor less than that the outgoing gases increase in density as the pressure falls or that he opens his exhaust valve backward.

Such a phenomenon might occur, to a slight extent, if we were dealing with steam where a great deal of entrained moisture was present, provided some outside source of heat were also present to suddenly reëvaporate the moisture. If Mr. Buschman is reëvaporating the smoke from his gas engines, he might at least put the rest of us "next."

Turning to the dotted lines, indicating, so Mr. Buschman says, what would happen with my valve setting, assume, for the sake of illustration, that the lines *A—D* and *D—F* are pivoted at the point *D* like a hinge; that we swing the end *F* around to the right, which would, in effect, double the stroke of the engine and make the lines *A—D—F* one continuous expansion line. The end *F* would still be much higher than the highest terminal pressure point of the expansion curve that *A—D* could possibly reach, notwithstanding the fact that from *D* to *F* the exhaust valve is supposed to be open. Does Mr. Buschman call such a monstrosity "true to life?"

Yes, I am willing to go on record that the same natural law governs the flow of air from the discharge of an air compressor into the receiver, from an absolute pressure at the compressor of, say, 80 pounds to, say, 79½ pounds absolute at the receiver, as in the case when gas is flowing from the exhaust outlet of a gas engine, from an absolute pressure of, say, 15 pounds to that of the atmosphere, 14.7 pounds at sea level.

Mr. Buschman speaks of a column of air in the exhaust pipe of a gas engine; will he kindly explain just how any air can get into the exhaust pipe while the engine is operating?

I will have to admit that the gas engine is a "hazy proposition" to me, but it seems to be in the air in this locality. There are now on the market in Chicago about fifty second-hand gas engines to one steam engine. Is this due to any inherent weakness or lack of adaptability on the part of the gas engine, or is it because I have lots of company? I suspect the latter to be true.

Mr. Buschman's reference to the time of exhaust opening in a high-speed steam engine opens a very interesting and attractive subject to me, but I will reserve my reply to that part of his letter until a future time.

E. G. TILDEN.

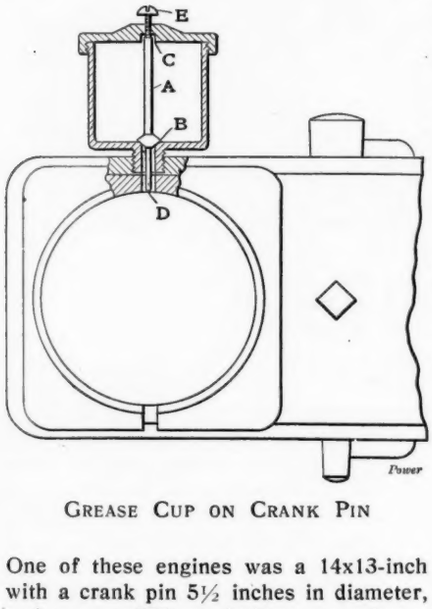
Downers Grove, Ill.

From READERS *with* SOMETHING *to* SAY

Practical information from men on the job~A letter good enough to print is good enough to pay for.

Grease as a High-speed Engine Lubricant

A few years ago I had two high-speed automatic engines which gave a great deal of trouble by throwing oil. I tried everything I could think of to prevent it, but finally gave the task up as hopeless. About this time the grease advertisements began to attract my attention, but the use of grease on the crank pins of high-speed engines running 12 or 14 hours a day offered difficulties which at first seemed insurmountable, although they were all finally overcome so completely that these engines were run entirely on grease for about a year.



GREASE CUP ON CRANK PIN

One of these engines was a 14x13-inch with a crank pin 5½ inches in diameter, and ran at 275 revolutions per minute. The other was a 10x12-inch with a crank pin 5 inches in diameter, and ran at 300 revolutions per minute. The cranks were oiled by a wiper which caught the oil from a wick in the usual manner. Naturally, the first question was, how to feed the grease. I made a few preliminary trials with a compression cup, attempting to regulate the feed by means of the screw in the throat of the cup. These were failures, as when the grease warmed up and softened, it would soon be all forced out. These trials convinced me, however, that if the question of feeding could be solved, the lubrication would be successful.

My attention was attracted by a grease which was fed by a copper pin which rested loosely on the journal, and extended up into the cup. As the journal warmed up the heat was conducted by this pin to the surrounding grease, which softened and ran down into the bearing. After considerable experimenting I succeeded in applying this plan very satisfactorily to the main bearings by using a sufficient number of pins. It also worked fairly well on the cranks, but the churning of the pins worked the grease through too fast as the heat of the cranks kept the grease quite soft. By this time I had become deeply interested in the subject. In fact, it had become a hobby with me, and as I had time and facilities for experimenting, I decided to try to utilize the churning action of the pins to feed the grease.

For this purpose I made the cup shown in the drawing. The plunger *A* rested on a seat at *B*, and fitted into a socket in the cap at *C*, holding it in a central position. This plunger was made of brass, with a copper stem which rested lightly on the journal at *D*, and helped to conduct the heat up to the grease, and soften it. The feed was regulated by adjusting the stroke of the plunger by means of the screw *E*.

By this means grease was used with success on both of these engines, and the trouble from oil being thrown was entirely overcome. The method of feeding the grease to the crosshead pins was the same as that used for the cranks, and the guides were lubricated by means of compression cups. I was surprised at the small amount of grease required for a run of 12 or 14 hours.

As might be expected, I kept the regular oiling devices in working order during all of these experiments, and at first they were called into service quite frequently, but after the proper adjustment was obtained with the cup described above, it was never found necessary to resort to oil.

Graphite mixed with the grease was tried several times, but no benefit was noted from its use, and it was not continued.

A great deal of trouble was experienced at first from the cups on the cranks working loose, and it was found necessary to screw the caps on with a light wrench, as the rapid motion would loosen and throw them off if this was not done. If the engine room is very hot, a hard grease should be used, but in winter or in a cool room a rather soft grade is better.

M. KENNETT.

Webster Groves, Mo.

Piston-ring Repair

I was assistant engineer in a small railway plant where we had only one engine and generator. It is plain that when the engine stopped the cars would stop also and as the engine had to run from 6:20 a.m. to midnight the time for making repairs was limited. One day a clicking sound was heard in the cylinder. When I spoke to the chief about it he said he had also heard it but had no idea what caused it. He said he would investigate, but that was the end of it as he never looked into the matter further than to remove the cylinder cover, look at the piston face, and replace the cover. Not finding the trouble, he dropped the matter. Then we got a new manager who started to make things hot. By the time the smoke had cleared away, only three of all the old employees were left. The chief engineer was gone and I was in his place.

Now it was strictly up to me to see what was wrong in that cylinder. After

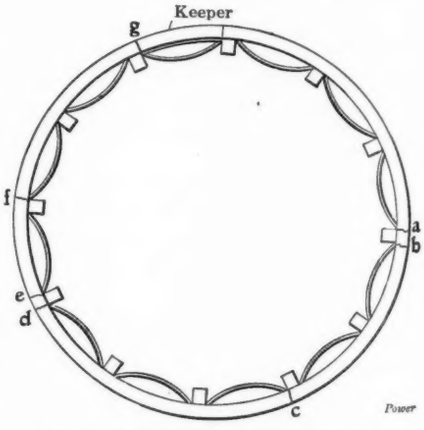


FIG. 1. SHOWING BREAKS IN RING

unscrewing the piston rod, removing the cylinder head and pushing the piston nearly out of the cylinder the packing ring fell out in pieces. The ring was broken in six pieces, as shown in Fig. 1, at *a, b, c, d* and *e*. The longest piece *e-g* broke at *f* when it fell out. The nearest place at which we could get supplies of any kind was 10 miles off. Our equipment for repair work consisted of a hand drillpress and a hammer. It looked impossible to repair the broken ring, but we had to have "juice" in the trolley wire at 6:20 a.m. First, we tried to replace the pieces of the broken ring which was a failure as you can imagine. Profanity did no good for my assistant

used plenty of it with very poor results. Then memory got on the job and there came to mind an article seen in POWER ages before, telling of some fellow using rubber packing temporarily in a steam-pump cylinder. Now packing makes a very good job if you have the right kind, but all I had was some 5/8-inch P. P. P. We had to do something, so decided to try it by using two rings around the piston, one on top of the other. We put the piston back in place and got the engine all ready to start on time.

Of course we telegraphed for a new

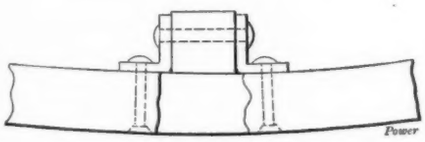


FIG. 2. DETAIL OF REPAIRS

ring and expected it would arrive in two or three days. I let my assistant go home at 8 a.m., and as I had business in a distant city on the following day, I had him come on duty again at 2:30 p.m. to take a short shift so he could work in my place the next day. At 9 p.m. I came on again and finished the run at midnight and was on duty again from 4:30 a.m. until 7:10 a.m., when my assistant arrived and I started for the city. Up to this time the packing had not given any signs of trouble.

When I returned at 9 p.m., I found my assistant having the time of his life. We usually carry 100 pounds steam pressure but he had only 60 pounds and said he was glad to have that much. The jet condenser was off the job as he did not understand adjusting the speed and water supply and the condenser would not handle the extra amount of steam it was getting by reason of the packing ring being entirely gone. After starting the condenser at an increased speed and giving it more cooling water it finished the run without further trouble. When I stopped the engine at the end of the run and looked at the piston, I found the packing completely gone.

Then I did what I should have done in the first place, I laid the pieces of the ring on the floor in their relative positions and proceeded to fasten them together. I found a piece of 1/8x3/4-inch strap iron which I bent and riveted to the pieces after the manner shown in Fig. 2. I drilled 1/8-inch holes through the end of the pieces and through the ring, as shown in the sketch, Fig. 2. Not having any rivets, I made some out of a piece of soft wire and after slightly countersinking the holes on the outside of the ring, riveted the strap iron to the pieces as shown. After getting all the pieces together, I filed off all uneven places as well as I could and after removing the follower plate put the ring and springs in place. The ring made a better fit than I expected. I got the head on again which is no easy job for one man, as there are a great many things which are lighter than the cylinder head of an 18x36-inch engine.

On the arrival of the new ring about a week later we put it in place. I found it was not necessary to disconnect the rod from the crosshead, for by shoving the piston to the head end I could replace the ring simply by removing the follower plate and one section of bull ring. It was necessary to center the piston as the centering wedges had become loose through wear.

This is only one of the many things I found wrong in this plant.

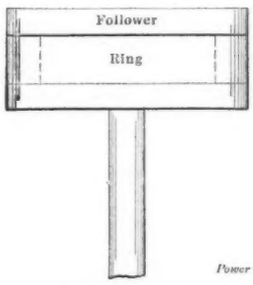
Remedying Piston Ring Troubles

In a triple-expansion engine, I have known the high-pressure piston rings to give a good deal of trouble, due to high-pressure steam, causing them to wear rapidly, break and cut the cylinder. I know of a steamer which had to have new rings every week. Ordinary cast-iron split rings were used and their rapid failure was due to the steam at high pressure (about 180 pounds) getting in back of them and pressing them out against the cylinder walls.

The following would be a good remedy for this: Use a big solid floating ring which is carefully turned to a fit, as shown. When this wears loose, have a new one made. This would be better than ordinary rings for the following reasons:

1. There is no friction no matter how much steam is carried.

2. Even if a little steam does leak by it is not lost but helps out in the intermediate cylinder in a triple-expansion



SOLID FLOATING RING FOR HIGH-PRESSURE PISTON

engine or the low-pressure in a compound.

3. The cylinder would not be worn out of round as is the case with ordinary rings. Spring rings on a piston valve wear the chest out of round very rapidly, thus spoiling the valve for good results.

4. There would be no danger of broken rings cutting the cylinder, and the engine would last longer.

I once worked as assistant engineer in a plant where we had lots of trouble with one of the engines. Among other things, there was a very disagreeable knocking somewhere, which the chief thought was in the piston rings, while I thought it was due to the valve. I told the chief that an easy way to determine whether or not it was the rings, would be to take them out and run without any for a short time. This was done and the noise instantly stopped, thus proving the correctness of his idea. The rings were in six sections with spiral springs back of them. It was found that these springs were too weak, and the substitution of stronger ones remedied the trouble.

Wants Information about Double-Eccentric Engine

I am running a 16x36-inch Corliss engine making 88 revolutions per minute. It is equipped with two eccentrics, one driving the admission and one driving the exhaust valve.

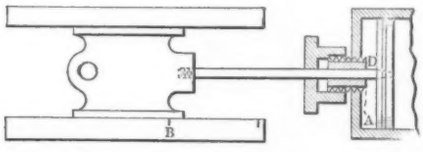
I would like to hear from some of my engineer friends as to what the advantage is in having two eccentrics. I would like to hear the experiences of those who have operated double-eccentric engines.

C. A. ECKERD.

Mogollon, N. M.

Pound in Engine Cylinder

A small slide-valve, steam engine that drives a blower and emery grinder in the Industrial building had a pound in the cylinder which caused considerable trouble for some time. Before locating this knock liners were put under straps, from time to time, for adjustment but to no avail as the pound continued and developed into what called for an immediate investigation. We began at once to try for clearance. After marking the crosshead guide as shown at *B* in the figure, we found that the piston struck in cylinder at *D* on the forward stroke. We then sought for proper adjustment of the clearance, but found that



STUFFING BOX SCREWED INTO CLEARANCE SPACE

the piston struck the cylinder head at the opposite end. Thinking that something had worked its way into the cylinder, the head was removed for thorough investigation. While turning the engine slowly by hand the stuffing gland showed indications of being loose. To our surprise we found the stuffing box had worked loose and the tightening of the gland had caused the stuffing box to screw into the cylinder, as shown at *A*, about 3/16 inch,

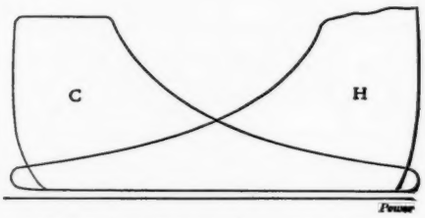
thus taking up the clearance. The piston was then taken out, the box readjusted and calked, after which the machine gave no further trouble.

WAYMAN J. LONG.

Jefferson City, Mo.

Criticism Wanted

This diagram was taken from a 16x42-inch Twin City Corliss engine running at



WHY ARE THESE DIAGRAMS NOT SATISFACTORY?

85 revolutions per minute. Would like to have the criticisms of POWER readers on these diagrams.

C. N. PHILBRICK.

Luverne, Minn.

Checking Shafting for Alinement

To ascertain whether two pulleys on parallel shafts are in line with each

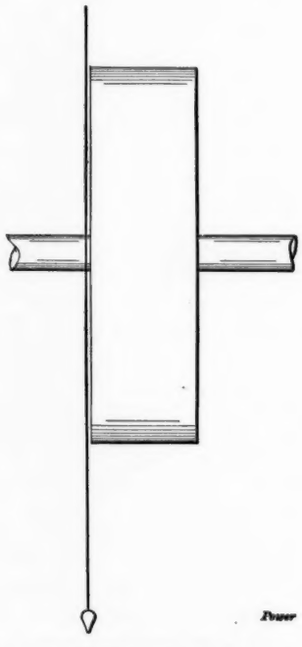


FIG. 1. TO DETERMINE IF PULLEY IS SET VERTICAL

other, fasten a string on the rim of one so that it projects out a little and run it over to the other pulley in the same fashion; if the pulleys are in line and the shafts parallel, the distances *A A A A*, Fig. 2, will be equal.

To find out whether the shafts are horizontal drop a plumb line down past the rim of the pulleys and, if it just ticks

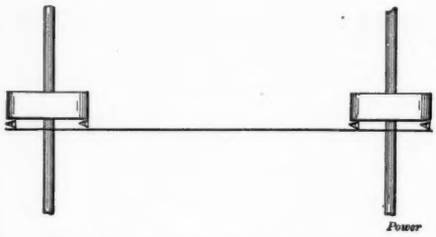
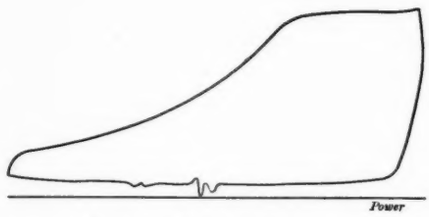


FIG. 2. CHECK FOR ALINEMENT

the rim top and bottom, the shaft is correct. Fig. 1 shows method of determining if pulley is plumb.

Jagged Exhaust Line

I had taken several diagrams from a cross-compound condensing engine and while looking them over before calculating the horsepower I came across one from the high-pressure cylinder with the irregular jagged back-pressure line shown in the following figure.



JAGGED EXHAUST LINE

This is the only diagram that showed this peculiarity and the only one I ever saw. I am at a loss to account for this and submit it hoping that someone will be able to tell me the cause of the peculiar back-pressure line.

F. W. TROSS.

Stoneham, Mass.

Low-pressure Cylinder Does All the Work

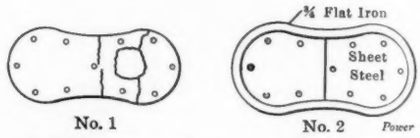
A 21x42x48-inch cross-compound Corliss engine with a long-range cutoff on the high-pressure side and a hand-regulated cutoff and single eccentric on the low-pressure side, is so overloaded that the high-pressure side will cut off at about ⅞ stroke. The low-pressure side then will not take all the steam from the receiver even with latest possible cutoff without the receiver pressure going up to a point where this side will be doing so much of the work that it is impossible to keep it from pounding dangerously. The engine runs condensing, with about 26 inches vacuum. I have been letting the crank-end, low-pressure steam valve carry steam full stroke and the head-end cut off as late as possible. Are there any better ways?

W. C. SCHUELER.

East St. Louis, Ill.

Pump Cylinder-head Repair

This is the way I repaired the head on the steam end of a feed-water pump which had been broken by being frozen.



THE BROKEN CYLINDER HEAD AND MANNER OF ITS REPAIR

The center had been forced completely out of one side and there were cracks clear across the head, as shown in the figure.

I made a ring of ¾-inch iron and shrunk it on after smearing the broken edges with red lead, leaving out the center piece. Then I cut out a half-head from heavy sheet steel and put it on outside of the broken end with sheet packing in between. When the repair had been completed, and steam turned on, it made such a tight fit that a new head has been considered unnecessary.

ROY B. STEARNS.

Hartford, Wash.

The Lost Boiler

Standing one day near the fire hole,
I was timid and ill at ease,
For I heard a sort of rumbling,
And a kind of a warning wheeze.

I know not what struck the stoker,
Nor what he had struck nor whom,
But I heard a bombilation,
Like a sound of the crack of doom.

It flooded the crimson twilight,
Like a crash of rending sky,
As he lay on the burning cement,
With a grate bar across his thigh.

It seemed an unending smash-up,
That would speedily end my life,
But who cares in the face of danger,
If it ends all joy and strife.

It linked all my breaks and bruises,
Into one perfect pain,
And it rumbled, whizzed and guggled,
As if it would come again.

I have sought but I seek it vainly,
The reason for that great sound,
That it came from the soul of the boiler,
As it threw me on the ground.

The plates were sound and perfect,
And the rivets spick and span,
I had the steam gage overhauled,
And tightened up the hand.

The safety valve was in good order,
And the water legs cleaned well.
Whatever caused that rupture,
I can never tell.

It may be a first-class earthquake,
Could bring such a sound to men,
And it may be that only in nightmares,
I shall hear that sound again.

FRED W. VENTON.

Chicago, Ill.

SUBJECTS UNDER DISCUSSION

Comment, criticism and debate upon various articles, letters and editorials which have appeared in previous issues

Experience of a "Trouble Man"

"Ignorance amazing! If any mortal comes in collision with it in large quantities it is the 'trouble man,'" writes William Westerfield on page 1036, in the December 21 issue, preludial to an interesting account of misshapen indicator diagrams, presumably taken from a 12

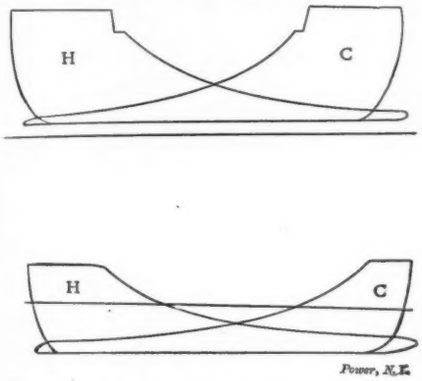


FIG. 1. HIGH- AND LOW-PRESSURE DIAGRAMS BEFORE ADJUSTMENT

and 24 by 36-inch Corliss engine, which are here reproduced in Figs. 1 and 2. Now I must confess to a little of that ignorance concerning these diagrams, and I hope Mr. Westerfield will explain how he managed to obtain them. Though slightly acquainted with a few makes of Corliss engines, I cannot conceive the

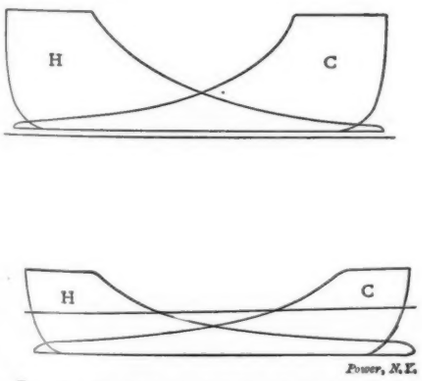


FIG. 2. DIAGRAMS AFTER ADJUSTMENT

possibility of causing the exhaust valves to open at the point shown in the expansion line of the high-pressure diagram of Fig. 1 without deranging such other points as release and compression. In the diagrams these events occur at identical points in both sets. After explaining that at the point of cutoff the expansion line drops straight downward, due to the opening of the exhaust valves, and that steam after cutoff is blowing into the receiver, he shows a diagram where the terminal pressure is higher than that in the corrected one. How can this be?

According to all rules of steam engineering, the terminal, not the back pressure, should be lower. He tells us that since the low-pressure cylinder has more work to do, the condenser must also have more work to do. The editors and correspondents of POWER have pounded into us the fact that the terminal pressure of low-pressure cylinder is governed solely by the cylinder ratio and the point of cutoff in the high-pressure cylinder. This being the case, I fail to see what influence the exhaust valves of the high-pressure cylinder have on the quantity of steam the condenser is called upon to condense. This quantity has been admitted before the exhaust valves open and no arrangement or disarrangement of the exhaust valves of the high-pressure cylinder or the steam valves of the low-pressure cylinder will affect the quantity of water the condenser must handle to maintain 25 inches of vacuum; for the steam admitted to the high-pressure cylinder, must and will expand to a definite terminal pressure in the low-pressure cylinder. The effect of the exhaust valves opening at the point indicated is simply to raise the receiver pressure (though in Mr. Westerfield's diagrams the receiver pressure in the corrected one is the higher).

It may be true that raising the receiver pressure will cause a compound engine to use more steam, but there are as many arguments against this as there are for it. Theory, certainly, proclaims the opposite to be true, just as certainly as Mr. Westerfield's indicator diagrams are worthless to disprove it. The knowledge of the scale employed is not necessary, to come to this conclusion. But were the diagrams presented really traced by an indicator while connected to the cylinder of a Corliss engine? Fig. 3 illustrates the positions of the piston and the exhaust valves of a Corliss engine as we might expect to find them in average practice and such as might produce the corrected diagrams shown by Mr. Westerfield. It is obvious that what the operator of that engine did, was to lengthen the exhaust rods *A* so that the valve overtraveled and opened the exhaust port at *B*. Such being the case, it requires little intelligence to note that in this event there would be no release and compression would be carried beyond the initial pressure and the back-pressure line would gradually rise toward the compression end, as the valve would not open the exhaust port wide.

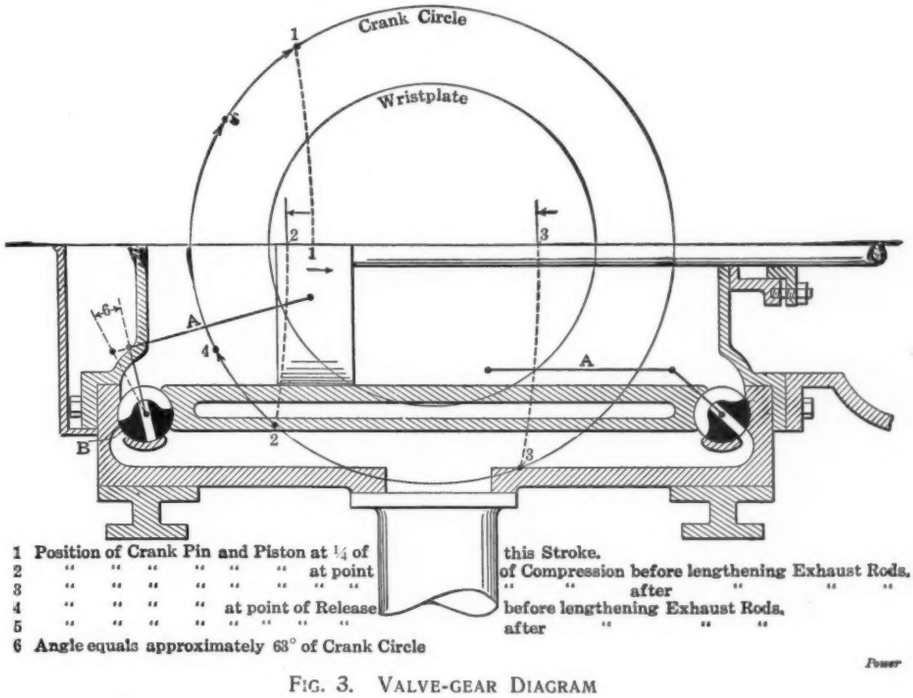

Crank Circle
Wristplate
1
2
3
4
5
6
A
A
B
1 Position of Crank Pin and Piston at ¼ of this Stroke.
2 " " " " " " at point of Compression before lengthening Exhaust Rods.
3 " " " " " " " after " " "
4 " " " " at point of Release before lengthening Exhaust Rods.
5 " " " " " " " after " " "
6 Angle equals approximately 63° of Crank Circle
Power

FIG. 3. VALVE-GEAR DIAGRAM

Even if the exhaust valve had opened while the steam valve was admitting

steam into the high-pressure cylinder, producing a nick like a rounded sawtooth in the steam line of a diagram, the engine would simply speed up from the extra steam admitted to the low-pressure cylinder and thus cut off earlier in the high-pressure cylinder; so that while it might show a comparable difference in the coal pile at the end of a week's service, it would be difficult to discover this at the end of a 10 hours' run with an engine of the size given. A compound engine of the Corliss type will stand a large amount of fooling with, without showing appreciable difference in economy, provided the steam valves of the high-pressure cylinder, and the exhaust valves of the low-pressure cylinder are not monkeyed with. This is daily proved in the performances of the Woolfe type of compound as well as in the remarkable records of compound engines versus triple-expansion engines, in which the total number of expansions were equal in each. It must not be inferred from the foregoing that the smooth-running qualities of the engine will not be affected.

H. HUGHES.

Roxbury, Mass.

National License Laws

Under the heading, "Incompetents at the Throttle," in the December 28 issue, POWER advocates more uniform license laws. I also think it is time for someone to make a move in that direction.

Within the last three months there have appeared in the columns of POWER accounts of five boiler explosions, all of which have caused an enormous property loss and the majority of them have caused loss of life as well. As another result, hundreds of men have been thrown out of employment for indefinite lengths of time.

Most of these explosions have occurred in States where there are no license laws. The boilers have always been reported to be in good condition. Nobody really knows why they exploded.

I think it is about time that engineers' and firemen's license laws were made national. Compare the marine license law with the stationary laws now in force and you will find quite a difference. It is very seldom that we hear any complaint against a marine engineer. The majority of stationary engineers are responsible for just as many lives and just as much property as is a marine or locomotive engineer.

If we had national laws, an engineer could work in every State. When an employer wanted an engineer, he could make sure of getting an engineer and not a saw filer or a Jack of all trades.

I have heard engineers say that they could not organize strong enough to do any good. I wish these men would look at the record of the Brotherhood of Locomotive Engineers. It is one of the strongest organizations in the country. The stationary engineers could become equally as strong if they would get together and stick.

L. W. CHADWICK.

Bridgewater, Mass.

A Transmission and Recording Dynamometer

In his article on "A Transmission and Recording Dynamometer," Mr. Hughes makes a sweeping arraignment of the prony brake dynamometer when he says that "Almost every form of brake dynamometer is utterly unreliable, if not worthless." This is certainly important news to those of us who have considered the prony brake to be the most accurate and reliable means for measuring power. After a careful consideration of the evidence presented, I am convinced that it is not guilty. The reasoning is correct so far as the derivation of the formula is concerned. The pressure on the scales with the arrangement of letters shown in Fig. 1 of the article, is represented by

$$T = \frac{Z}{V+Z}\left(W + \frac{WX}{Y}\right).$$

The conclusion that this is not equal to W is not well founded. The quantity

$$W + \frac{WX}{Y}$$

in the formula might be expressed as

$$W\left(1 + \frac{X}{Y}\right)$$

or

$$W\left(\frac{X+Y}{Y}\right)$$

and hence

$$T = W\left(\frac{X+Y}{Y} \times \frac{Z}{V+Z}\right).$$

T will be equal to W when

$$\frac{X+Y}{Y} \times \frac{Z}{V+Z} = 1.$$

Let P equal distance from C to the center of the shaft and let L equal length of arm. Then, from similar triangles

$$\frac{X+Y}{Y} = \frac{L}{P}$$

and

$$\frac{Z}{V+Z} = \frac{P}{L}.$$

Substituting these values in the formula for T we have

$$T = W \times \frac{L}{P} \times \frac{P}{L}.$$

After canceling, we have left

$$T = W.$$

W. W. WELLS.

Clyde, O.

Referring to Fig. 1 of the article, the expression for the W_1, on one lever, which will balance a weight W on the other is:

$$W_1 = \frac{Z}{V+Z}\left(W + \frac{WX}{Y}\right).$$

By similar triangles, we have:

$$\frac{Z}{V+Z} = \frac{Y}{Y+X}.$$

Hence, the first equation may be written:

$$W_1 = \frac{YW(Y+X)}{Y(Y+X)}$$

which is exactly the reverse of that which was to be proved.

This seems to indicate that the paradox mentioned, must be explained in some other way.

HENRY C. LEHN.

Williamsville, N. Y.

Mr. Hughes states that most brake dynamometers depend upon a principle which makes them unreliable, if not altogether worthless, and proceeds to prove why this is so. He claims that a weight of W pounds supported at M' will not produce a force of W pounds at M and works out the value of the force at M as follows:

As the shaft and levers are practically one solid mass, the weight W at M' will tend to rotate about the line MB' as an axis. The resisting force at bearing B will be equal to

$$W\frac{X'}{Y'} \text{ or } W\frac{X}{Y}.$$

The force acting down at point C will be $W + W\frac{X}{Y}$ and the portion of this force which will be transmitted to point M will be

$$\frac{Z}{V+Z}\left(W + W\frac{X}{Y}\right).$$

This value is correct and when simplified becomes equal to W and not some other value as Mr. Hughes claims. To prove this statement, draw the line MM'. Then the triangles BBB' and MCM' are similar and the following equation may be written

$$\frac{X}{Y} = \frac{V}{Z}.$$

Substituting this value of $\frac{X}{Y}$ in the formula, it becomes

$$\frac{V+Z}{Z}\left(W + W\frac{V}{Z}\right).$$

Simplifying,

$$\frac{Z}{V+Z}W + W\frac{V}{V+Z} = W\left(\frac{V+Z}{V+Z}\right) = W.$$

M. A. CHARAVAY.

Jersey City, N. J.

If some of these mathematicians would stir just a few pinches of the common or garden variety of horse sense into the deductions they sometimes make, although depriving us of much merriment, they would avoid considerable confusion to themselves. Mr. Hughes, no doubt, sees by this time the flaws in his rea-

soning; therefore, it is superfluous for me to set him straight with respect to his mathematical error. In his defense, it may be advanced that he went at the task of explaining the "paradox" before "the almost paralyzed brain" had become fully restored.

The moral to be observed is, when in doubt, use common sense. In the halcyon days at school, when I thought I knew something about mathematics, it gave me much glee to find that I could prove, algebraically, that one equaled two. There was not a fault in the whole proof; by legitimate algebraic reasoning one equaled two. I took it up to my kind old teacher, and told him I intended to give up the study of algebra because it was a fraud and a delusion. Of course he soon set me straight and with a few well chosen words showed me that it is essential to leaven with common sense everything we do.

PHIL LIGHTE.

Brooklyn, N. Y.

High and Low Water Alarms

Every water alarm should blow for both high and low water. My own troubles and those of others within my observation have been caused more often by high than low water. There have been more engine wrecks from high water, than there have been boiler explosions from low water. A proper and safe alarm should give a different sound for high water than for low water, so that everyone would know which the alarm was blowing for. This could be accomplished by two whistles of different tones or one whistle having two tones.

All water regulators should have attachments for giving audible alarm if from any cause the water became higher or lower than the limits which the regulator was set to maintain. When so constructed, these devices become a great protection against danger.

Steam seperators are all right, but rarely needed except for high-water emergencies or in cases where the boilers foam badly, and under these conditions they are useless because of insufficient capacity to drain away quickly the large quantity of water they catch. I have run engines which would repeatedly pass unevaporated water in large quantities without distress. I could tell that the engines were handling lots of water from the fact that the exhaust outlets were half full.

All water glasses should be provided with arrangements to shut them off automatically when the glass breaks. The shut-off device should be capable of operating no matter what the nature of the break is, be it instantaneous or only a slow cracking. Most of them work well enough when the failure is sudden and complete but do not work when the glass fails gradually.

Besides cutting by means of a file there are other ways in which a glass can be cut to proper length. A way sometimes found convenient is to wrap a string soaked with turpentine about the glass at the proper point and then burn the string off, causing the glass to break at that place. This method has been tried with success by the writer.

F. R. WILLIAMS.

Syracuse, N. Y.

In the January 4 issue, the article on "Water Columns," gave several pointers about different methods of connecting them to the boilers, advantages, disadvantages, etc. There are conditions in boiler operation under which the double-float, high- and low-water alarm such as shown in Fig. 4 of the article can be a general nuisance.

At one time we had one of the so-called standard makes. It worked fairly well during regular operation, and when the water stayed within narrow margins of the normal level. But when the water got too high so that the upper float acted, the lower float was affected also and the result was an interference of the two sets of levers operating the whistle. The valve was held open after the water level became normal and the whistle blew all the time. Of course the alarm indicated high water all right, and the whistle called attention to what would ordinarily be the carelessness of the operator, but owing to the mixup, the whistle would not stop when it ought. There are occasions, however, not due to carelessness, when a boiler may be filled with water to a higher level than that required for normal operation. In any case, whether you wanted it, or didn't want it, a "take down" was necessary in order to rearrange the internal works of the thing. This style of job is never pleasant. It requires a valve in each of the pipe connections so that the whistle can be "choked off," thus cutting the column out of service for repairs. In case it was set to fill to a high level, the column would have to be cut out so as to save making the troublesome "take down" afterward. The valves in the connections are also a source of possible danger.

F. WEBSTER.

Scranton, Penn.

Why the Vacuum Improves

Replying to Mr. Sayles' question, "Why does the vacuum improve?" in the January 11 number, I think the 1½-inch valve leaks until it is opened and quickly closed. By the quick turn the disk is pressed tighter against the seat and consequently the vacuum picks up. I suggest that the valve be disconnected temporarily and a plug put in the hole in the exhaust in order that the effect may be noted.

W. S. WERBECK.

Saratoga Springs, N. Y.

Water Tank Indicator

The most convenient way to make a water-level indicator is to light a pipe—a cigar will do—get out a piece of paper and draw a 4-inch pipe vertically in a tank. At the top of this pipe make a correct representation of a 4x⅛-inch reducing cap, the bottom end of the pipe being left open, and shown supported about any old distance from the bottom of the tank. A line of ⅛-inch pipe is run to a desirable point and a light-pressure gage attached to the end of the line.

As the tank fills up it is evident to some engineers that the air trapped in the 4-inch pipe cannot escape; hence, it must undergo compression. (Note to the draftsman: Show water-level inside of pipe lower than level in tank.) Since the rate of compression is supposed to depend on the hight of the water in the tank, the gage indications will increase as the water rises in the tank.

Paste a disk of paper over the dial of the light-pressure gage and make same movable as it will want recalibration every few hours. Where the tank is located a great distance from the gage have something handy to keep you good natured or something may drop. This system keeps you working, running all the time, and you will not have any rest until you attach a bicycle pump to the small pipe and shove in enough air to give you the correct reading.

H. F. HEYRODT.

Bridgeport, Conn.

Cure for Troublesome Belt

In the January 4 number, Mr. Berkley tells of trouble he has with the belt drive on an alternator. I have had trouble myself with belts stretching on one side and have remedied them by placing a leader on the troublesome pulley. In this case I should suggest a piece of 1½-inch single leather belt tapered on both edges with a plane or sharp knife. If the pulley is of the composition kind, the leader can be tacked on with copper tacks. If it is of cast iron with spokes, then a few 3/16-inch holes should be drilled and copper rivets inserted through leader and pulley, taking care to have the heads of rivets sunk into the leader. The leader should be placed two-thirds of the face of pulley away from the side on which the belt comes off. After being on for about two weeks Mr. Berkley will find he can dispense with the leader altogether as the belt will gradually stretch and give a uniform tension which is not the case at present.

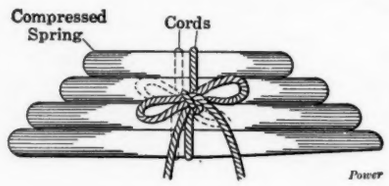
GEORGE H. HANDLEY.

Newburgh, N. Y.

Putting in Pump Valves

I read with interest Mr. Sheridan's article in the January 18 number under the heading "Putting in Pump Valves."

I think I have an easier and quicker way of doing it. Instead of putting the string around the valve and over the



SPRING COMPRESSED READY TO BE PUT IN PLACE

stud I tie the spring separately, after compressing it. I use a string long enough to tie in a bow knot and use two strings, one on each side of the spring. This is quicker than tying one string around both spring and valve. With my method, spring and valve can be put through the hole in the pump separately, which is sometimes easier. After the stud is screwed in a little the string is released and pulled out. With Mr. Sheridan's method there is danger of the string slipping off the top of the stud.

FRED H. STANLEY.

North Adams, Mass.

Station Experience

In the December 28 issue, Mr. Collins speaks of a case of waterhammer which I happened to be very much mixed up in, for I opened that 5-inch valve which caused the mischief.

With Mr. Collins' permission, I will make a correction; the valve on the drain pipe was open when we arrived in the morning, but the piece of hose leading from the drain pipe to the outside of the boiler room was frozen. The night foreman did not want the water on his floor, so he put on a piece of old hose and ran it through the north door. The door was about 12 feet below the steam main and 8 or 9 feet above the floor of the boiler room, and the hose sagged some before it got out doors, forming a pocket. The night being bitter cold and the outside end of the hose not being watched, it soon became frozen.

In the morning the drain valve was found to be open. So we opened the 5-inch valve leading to one of the engines; then the "fun" commenced. The main had a desire to go both ways at once, the expansion joint let go and steam was everywhere.

The 5-inch valve was closed very quickly, then a jump was made for the 8-inch gate valve on the large Haselton boiler connection. This was also closed very quickly. When this had been done, things became normal. When we got down from the gallery, not a soul was in sight; but soon heads began to appear at doors and windows, and then repairs were started and we had things moving again that night.

Another incident in connection with this main and boiler is vividly recalled.

It was on a Sunday afternoon toward six o'clock, we had just started the large units; all seemed smooth and smiling and I had taken a chair at the door leading to the street to take a smell at the good cigar left us by the oil man, when a sudden explosion and rush of steam in the boiler room at my back, brought me up standing. Firemen and coal passers were going out of doors as fast as their legs could carry them. Jumping to the platform leading to the steam-main gallery, I found the 4-inch feed-water main leading to one boiler had parted.

The 8-inch gate valve shutting this boiler off from the main had to be closed.

Putting on a rain coat and wrapping a wet towel around my head, I started for the valve and closed it.

It was found that the 4-inch pipe had pulled out of the flange on the shell of the boiler.

A. R. BORENEMANN.

St. Paul, Minn.

What Caused the Fitting to Break

In the January 18 issue Mr. Seeley asks why the fittings on an underground steam line should break and what methods to take to prevent further accidents.

As this is a low-pressure heating system the increase in temperature of the pipes when steam is turned on must be somewhere in the neighborhood of 150 degrees Fahrenheit, which will cause the line, 300 feet long, to expand about 3 inches. Some means must be found to take care of as much expansion as this, and while it would be possible to use expansion joints, swing joints for pipes up to 3½ or 4 inches give every bit as much satisfaction and cost very much less. They have the advantage that they require no attention, which cannot be said for expansion joints. I know of one underground heating system that was installed some twenty years ago with several 4-inch swing joints in the mains and up to the present time they have never leaked and are still doing service.

According to the sketch shown, there is no method for taking care of the expansion in the return line and only one expansion joint in the main line. No wonder the fittings were continually breaking. I would advise Mr. Seeley to put swing joints at each manhole in both the main and return line and if possible at the feed end of the pipes.

JOHN FRENCH.

Washington, D. C.

Device for Stopping an Engine

Referring to "Device for Stopping an Engine," in the January 11 issue, I fear the writer has forgotten about the other side of the valve. I think he will find the slide valve to be open at the end he would like to get pressure enough in to stop his engine, and the steam will whiz out through the exhaust pipe, and the engine will come to a stop when it is good and ready. If by some means, unknown to the writer, he did get the ports covered, there being no pressure on the valve, it would simply blow off and let the steam out just the same.

I have tried this device to my sorrow.

Give us actual experiences; we cannot profit by reading of "dreams."

G. M. BROWN.

Magnolia, Miss.

Writing for Catalogs

I have been following the discussion on "Writing for Catalogs" with much interest. There have been many good points brought forward.

Having acted as a traveling salesman for one of our representative manufacturers, I feel that I am in a position to shed new light on the subject. All large concerns have a force of salesmen whose duty it is to follow up prospects. A request for a catalog is generally considered a good excuse for a call. In many cases, more than one would realize, the salesman finds that the request comes from a boy in school.

Experience goes to show that the school boy and most men, write a letter consisting of this one sentence:

"Please send me a copy of your catalog." The manufacturer can judge only from appearances. If the letter is written on a letter head, it gets immediate consideration, otherwise, they consider the wording and other features.

With all due respect to our firemen and mechanics, we find that most of them are more artistic with a coal scoop or hammer than with a pen and can make a better score wrestling with a formula than with a grammar.

I have always made it a practice, when writing for a catalog, to state whether or not there was any business to follow or else say that I was interested as a student only. I have yet to get my first refusal and have received everything from a penny folder to a bound volume costing a dollar or more, also many expensive advertising novelties such as rules, levels, etc.

If the writers of requests for catalogs would be more explicit as to their occupation, the possibilities of future business and other useful information, they would have more courtesy extended to them. Try it.

H. K. WILSON.

New Bedford, Mass.

Cylinder Lubrication

I had a new 18 and 34 by 42-inch cross-compound Hamilton Corliss installed in an electric station some years ago. The engine was direct connected to an alternating-current generator and made 102 revolutions per minute. The engine ran two weeks under a heavy load on four drops of Dearborn Douglass XXX cylinder oil per minute in the high-pressure cylinder. Then I began very gradually to cut down this quantity. After about a year's time, the engine was being operated 24 hours a day on one drop of oil in the high-pressure cylinder every 60 revolutions. In the low-pressure cylinder, I used a compound of Dearborn Douglass XXX cylinder oil and 50 per cent. Dearborn, Fort Lincoln engine oil at the rate of one drop every 70 revolutions.

The engine has operated satisfactorily on this quantity of oil for five years. The steam pressure is 140 pounds, the receiver pressure ranges from 15 to 35 pounds and the vacuum is about 28.5 inches.

H. NOTTHOFF.

Los Angeles, Cal.

Speed Limiting Device

On page 1019, issue of December 14, a new design of safety device is illustrated, as applied to Corliss engines. This device will certainly do the work claimed for it, but after studying the drawings it appears to me that it will not meet with very much approval, because when the main governor fails and this secondary governor becomes operative, the speed of the engine will be kept at normal speed by varying the number of impulses the piston receives; that is, each stroke of the piston will not be a power stroke as under ordinary conditions; this secondary governor by its connection to the safety cams prevents any admission of steam to the cylinder as long as the speed of the engine is slightly above normal; any reduction of the speed below normal brings the safety cams back so that steam is admitted to the cylinder, and when the main governor is not operative the point of cut-off is at its full range so that each stroke of the piston will develop its maximum energy. Thus, when the secondary governor is operative, the engine operates like a gas engine; the impulses or power strokes are intermittent and each power stroke is a maximum power stroke. This I believe will be a very unsatisfactory method of steam-engine regulation even for the short times it may be used.

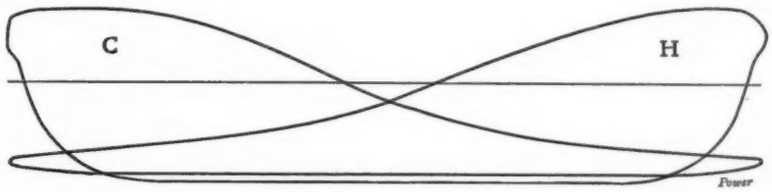
It appears to be hardly necessary to apply a second governor to an engine, for the reasons stated in the description on page 1019, because when the main governor becomes inoperative, thereby stopping the engine, the engineer can raise the governor on to the safety rest and regulate the speed by the throttle until the mill can be run empty or until the governor can be attended to.

HARRY W. BENTON.

Cleveland, O.

Freak Diagrams

In the early summer of last year you published an indicator diagram with both ends interconnected, sent in by J. O. B. Latour, who wished to know the cause of the freak diagram. I have done some studying trying to find the reason but was unable to do so. In October last I took the inclosed diagram and my interest was again aroused. This diagram is from the low-pressure cylinder of a cross-compound condensing engine running 93 revolutions per minute. This freak was the only one out of a number taken.



FREAK DIAGRAM (FROM LOW-PRESSURE CYLINDER)

JAMES PHELPS.

Sarnia, Ont.

Hight of Water Column in Siphon Condenser

On page 1048, December 21 issue, J. S. Labonne asks why the end of the tail pipe of a siphon condenser must be in the water.

If he will shut off steam from the engine and shut off water from the condenser the water in the tail pipe will run out until it reaches a hight where the atmosphere will balance it. After that, should the vacuum in the pipe improve a little the atmosphere will throw the whole charge over into the cylinder and there will be a story of another siphon condenser that has sucked the water over. This has been done when the hotwell was too shallow to keep a sufficient hight of water in the tail pipe.

Where the tail pipe is covered with sufficient water to maintain a full column in the tail pipe a siphon condenser is safe and water will not be sucked over, but where there is not sufficient water to preserve this column there is always danger from the atmosphere lifting it over and the illustration shows a big chance taken.

W. E. CRANE.

Duluth, Minn.

Weir Measurements

Referring to Mr. Van Winkle's article on "Weir Measurements" in the December 28 number, I would say that to even the most experienced, this method of gaging the volume of a stream is most unsatisfactory, and should be adopted only as a last resort. Where accurate results are vital, two weirs should be built at different points in the stream to serve as a check one upon the other. Testing flumes were built at Holyoke and Lowell, Mass., and have been tested and retested, and from the results obtained with them, formulas have been worked out which are now generally used throughout the United States. The Francis formula, I believe, is the standard.

The method of ascertaining the hight of water on the weirs by means of a stake and square, as indicated by Mr. Van Winkle's illustration, is not accurate, owing to the influence of capillary action. The only way to gage the hight accurately is by means of the hook gage. When elaborate tests were being made to determine the efficiency of turbines at the Philadelphia Exposition, the water was measured by running it into tanks. This is the only accurate way to measure the discharge. For velocities up to 300 feet per minute, measuring in boxes or tanks will be found convenient; for greater velocities, the most satisfactory way is to determine the cross-section of the stream and observe the velocity of the current. I once gaged a stream this way by figuring the cross-sectional area at two different points 1000 feet apart, getting the velocity by timing floats with a watch and by taking the hight of the water with hook gages. The results checked within 4 per cent., and I have never seen results from two weirs which could be made to agree as closely as this.

Of all the substances known to man, water is probably the most wonderful. Its particles seem to move over each other without any friction whatsoever. Water from one vessel will discharge into water in another vessel more rapidly than it will into the open air. For the inexperienced person I know of nothing better left alone, excepting, perhaps, the steam-engine indicator, than the weir.

E. T. ABBOTT.

Pokegama, Ore.

Boiler Explosion at Midvale, Ohio

Two Firemen Killed. $24,000 Property Loss. Explosion Probably Due to Water Hammer Caused by Injudicious Lifting of Safety Valve

On December 17 a boiler exploded with disastrous results at the plant of the Robinson Clay Products Company, Midvale, O. There were in operation eight horizontal tubular boilers at the time of the explosion, all connected together and with safety valves loaded to 100 pounds pressure. Six of the boilers were 60 inches in diameter by 16 feet in length, two being 72x18 inches. Each was provided with a 4-inch lever safety valve and in addition there was a 5-inch lever valve on the main steam pipe. The boiler which exploded had a 60-inch shell built of ⅜-inch plate, with lap-joint double-riveted longitudinal seams. The initial rupture took place in the shell plate at the front head about 20 inches above the longitudinal seam, extended backward about 6 feet, then upward to the center and through the manhead, then downward diagonally to the opposite longitudinal seam. From this point the rivets in the seam sheared to the rear head, a distance of about 4 feet. The back head was bent outward, shearing part of the rivets. The shell opened and the tubes were projected upward and scattered over a wide area, destroying or damaging property to a considerable extent. Two other boilers were thrown out of their settings and badly damaged.

The boiler house, a brick structure, was destroyed. All the pipe work, fittings, etc., were ruined, including boiler fronts and smoke connections. In addition, other buildings near by were injured and machinery damaged by the explosion, the total property loss amounting to about $24,000.

Two firemen were instantly killed, the body of one being blown a distance of about 800 feet.

Examination of the exploded boiler showed no evidence of low water or defects that might explain the explosion. The metal along the line of rupture showed a reduction in area of from ⅜ to 5/16 inch in the solid plate. Nor was there evidence of structural defects in the 4 feet of the longitudinal seam through which the rupture extended. Test pieces cut from the fractured plate gave a tensile strength of 67,000 pounds, and the joint figured to an efficiency of 70 per cent.

Inquiry concerning working conditions just prior to the explosion shows that the 4-inch lever safety valve on the boiler that exploded was leaking, probably due to sediment on the valve seat. The fireman of this boiler went on top, and, it is reported, was opening and closing the valve, by lifting the ball and lever, trying to blow out the sediment on the seat when the explosion occurred, hurling the unfortunate man 800 feet over a four-story building. At the instant of explosion the boilers were all in operation and under about 95 pounds pressure.

From all accounts the explosion was chargeable to water hammer induced by injudicious lifting of the safety valve.

FIG. 2. REMAINS OF THE EXPLODED BOILER

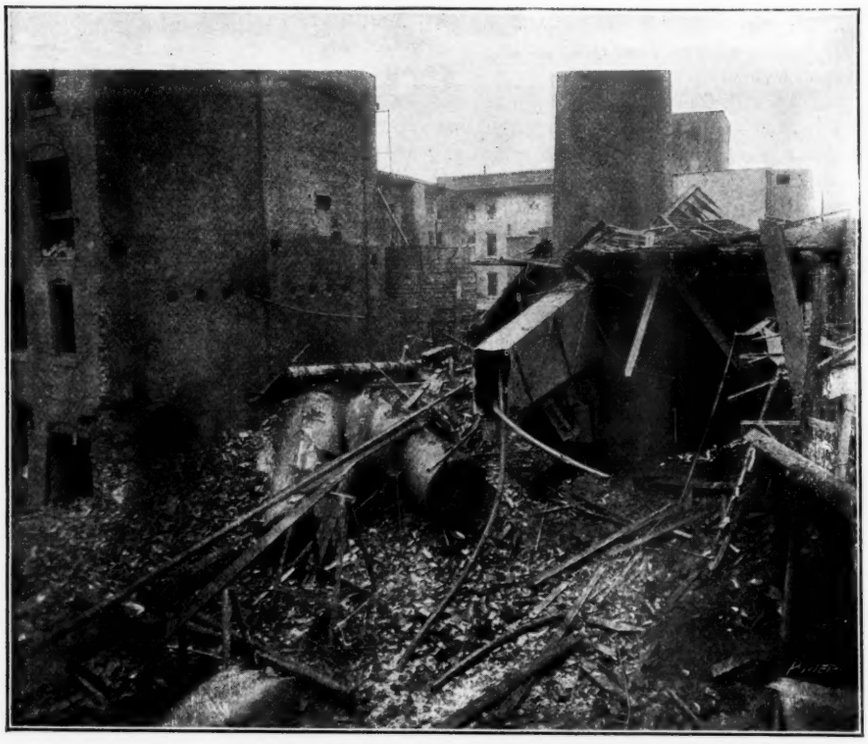


FIG. 1. THE RUINS AFTER THE EXPLOSION

The Importance of Mechanical Power*

Its Part in Supplying Daily Wants. Progress Made in the Science of Power Generation. Necessity for Future Advancement and the Importance of Conservation

BY CHARLES EDWARD LUCKE†

In the days when the great numbers of the people were farmers, when little mining was practised and practically no manufacturing, about the only unusual or extraordinary happenings were the wars, so it is not surprising that a history of the period should be a record of these conflicts. Later on, however, things changed, industrial affairs assumed more importance as factories were built, drawing men from farms and concentrating them in factory towns, and stimulating the development of steam ships and railroads to bring raw materials to the factories and distribute their products, giving more and varied employment to others and supplying all with new forms of the necessaries and luxuries of life, completely changing the whole social organism. Referring to the importance of these industrial changes which is slowly but surely becoming accepted as it should be, is a well worded statement in Robinson & Beard's "Modern Europe:"

"The story of mechanical invention is in no way inferior in fascination and importance to the more familiar history of kings, parliaments, wars and constitutions. The chief factors in it never stirred an assembly by their fiery denunciation of abuses nor led an army to victory nor conducted a clever diplomatic negotiation; on the contrary, their attention was concentrated upon the homely operations of everyday life, the drawing out of thread with distaff or spinning wheel by the housewife, the slow work of the weaver at his primitive loom, the struggling of the miner against the water which threatened to flood his mine. They busied themselves perseveringly with wheels, cylinders, bands and rollers, patiently combining and recombining them until after many discouragements they made discoveries destined to alter the habits, ideas and prospects of the mass of the people far more markedly than all the edicts of the National Assembly or all the conquests of Napoleon taken together."

The often-heard characterization of our times as the "industrial age" and of our most influential citizens as "captains of industry" is an indication of growing respect for the manufacturing and transportation industries not as mere occupations or means of employment, but as world-shaping forces stronger than armies and navies and marks of appreciation of the fact that the training of engineers is more important than that of generals.

When it can be promised that an examination of the power generating processes and machinery on which so much of general interest and personal welfare depends, will also reveal the workings of broad, philosophic laws applicable to all human affairs with profit and show the systematic way in which the location and reduction of waste in all things are accomplished, mere curious questioning may well be expected to change to enthusiastic study.

We are every moment surrounded by the products and results of mechanical power and driven machinery in almost infinite variety. Not only are the clothes, hats and shoes we wear, produced by power-driven machinery, at least in part, but so also are all the fabrics of the household, such as the linens, carpets and hangings, and the furniture, glass, chinaware and metal house furnishings and practically all that enters into the making of the house itself, such as cement, bricks, pipe, nails, furnaces, radiators and lamps.

In addition we use power-generated electric light and bathe in power-pumped water, ride in powered cars and boats, make war with power-made guns, and with ships each containing several million dollars' worth of machinery. The very food of our tables is conveyed from the waters, forests and farms by highly developed systems of transportation, preserved by machine processes or stored between production and need in power-cooled refrigerators, and we cool our beverages by manufactured, pure ice.

The discovery that energy was available in nature for the doing of man's work is sometimes traced to his natural indolence when he placed sails on boats to move them along and paddle wheels under waterfalls to lift weights, even though no idea existed that the capacity of the moving air and moving water to do these things was proof of the existence of energy in nature and exactly similar to the capacity of a fire to melt things or extract metals from ores.

Culture and full enjoyment of life are possible only when the demands for the necessities have been satisfied, or speaking more broadly, national prosperity is a necessary prerequisite to civilization, and that nation is most permanently prosperous in which production of wealth is the more universal occupation, wealth derived primarily from the farm, the sea, the mine and the forest, the raw materials of which are augmented in value by manufactures, giving rise to transportation and commerce. In all of these industries, basic to national security and happy living, mechanical power plays a part more important in some than in others but an important part in all. Practically all our fish products are gathered in power boats today; mines that can raise the ore to the surface without power are rare, and still more rare are the ores that can be reduced to metal without it; the farmer is resorting more and more to power, one manufacturer alone last year having sold 30,000 gasolene engines for farm use.

Not only does the manufacturing process add to the wealth of the country by increasing the value of the materials used nearly 80 per cent., but it also gives a value to the raw materials which they did not possess in their original state. There would be little demand for iron ore without means of extracting the iron and making from it things that people want; fruit, vegetables and fish are produced at definite seasons and are worth more since means of preservation and cold storage were developed than before; the machinery for making shoes has so increased the demand for shoes as to give increased value to hides or an equal value to more of them. Coal tar was once an annoying byproduct of gas works, but is now a source of medicine, beautiful dyes and perfumes. Cotton seed has become valuable as the source of a useful oil; in 1860 it was garbage, in 1870 a fertilizer, in 1880 a cattle food, in 1890 a table food. Certain parts of animals slaughtered for meat were once annoying waste; now every part is utilized and from the former waste such byproducts are made as gelatin, glue, brushes, oils, buttons, medicine and soap. What was once useless has been made useful, and that which had value has been given ever increasing value by manufacture, so that the prime producing industries of farming, fishing, mining and lumbering may be said to be largely supported by the manufactures, transportation being the connecting and similarly dependent industry, and of this complex scheme the vital factor is the power plant without which the operating machinery would be lifeless and impotent.

In trying to realize the progress that has been made, which is the first step toward appreciation of our present situ-

*Abstract of the first Hewitt lecture delivered February 7 at Cooper Union hall, New York City.

†Professor of mechanical engineering in Columbia University.

tion, it is helpful to consider some contrasts which tell the story of the magnitude of industries practically nonexistent before power was made available. In earlier days there was nothing but the water and windmill, and about all they did was to grind grain, lift hammers or blow bellows for furnaces; boats were small and moved by sails, and land transportation was dependent on the horse. Compare these of the old conditions with the following illustrations of the present:

The New York subway power house, occupying a whole block and having a capacity approaching a hundred thousand horsepower, filled with seemingly complicated machinery. This power station, while one of the largest, is only one of hundreds of similar ones located in every city in the country. The modern steamship "Kaiser Wilhelm" would have been no more wonderful or unreal to the owner of the old windmill or the captain of the small sailing vessel of the days before the steam engine than would a vision of heaven. This vessel, some seven hundred feet long, carries deep down below the waterline a large steam-power plant, with nineteen boilers, each seventeen feet in diameter supplying steam to ten engines with a total capacity of nearly fifty thousand horsepower.

No less impressive is the comparison of the old horse and wagon as the sole dependence for moving goods on land, with a modern locomotive, one of the latest and heaviest of which, built for the Erie railroad and a complete steam-power plant in itself, is capable of drawing across the country at a high rate of speed half a hundred cars, each carrying fifty tons of coal. There are no statistics of steamship transportation available, but the railroad business, so largely supported by the manufacturing industries, is fairly well determined, and included in 1900 a passenger mileage of over one and a half billion or over two hundred miles per capita of population, while the freight haulage was equivalent to one hundred and forty-one billion, six hundred million ton-miles (one ton hauled one mile).

In round numbers 85 per cent. of all the power last reported in use in this country for manufacturing is derived from the combustion of fuel in steam boilers which deliver steam to engines and other apparatus capable of producing mechanical motion.

Coal is the main fuel dependence now and there was produced in 1907 about 450,000,000 tons. The railroads alone used in 1906 ninety million tons for which was paid $170,000,000. At the present rate the known supply of anthracite will be exhausted in about 70 years. The bituminous supply will last longer. It is estimated by E. W. Parker, of the United States Geological Survey, that if the present rate of increase continues for 150 years and the consumption then becomes constant the supply will last 700 years. Estimates place the water-power capacity of our streams at 30,000,000 horsepower of which only 10 per cent. is now used. So long as these natural supplies are depended upon, great care must be exercised in preventing waste, but it must be remembered that millions of square miles of land, especially in tropical countries, can be put under cultivation to produce wood for fuel or more rapid growing substances like sugar cane, sorghum, corn or potatoes bearing starch or sugar, which can be converted into alcohol in never ending supply. The determination of just what fuels and what systems of transmission to be used now and in the future depends on the cost of the power produced, which is a negative measure of waste. That source of energy and system of machinery will be used which produces power with the least net waste; that is to say, the least waste of energy, of man's labor, of wear in machinery and of investment. The prediction of the industrial future of the country, which in turn so powerfully influences its social and economic welfare, reduces to a study of reduction of waste.

By making studies of nature's substances and nature's stores of energy, and evolving means of using the latter to do the work of transporting and converting the former, not only is the wealth of the country enormously increased and the general average of living likewise raised, but direct employment as wealth producers and traders in goods produced is created for ever increasing millions of population. The success of industrial undertakings, dependent as it primarily on the economic use of power, is, however, and always will be impossible without men of every walk of life and of every degree of physical strength, mental power and education. Equal as men may declare themselves to be before the law in their right to live without annoyance from others, no sane man can believe they are equal in attainments or that the attainments of any one man cannot be increased by study, training and experience. Were we all farmers or all weavers of cloth there would be no possibility of finding an occupation for each, best suited to his ability. The creation of these varied industries has had the effect of diversifying the duties of the army of men necessary to conduct their affairs. There is now work to be done in infinite variety and different in difficulty, so that the most ignorant man may find a useful place in the same establishment with the one most richly endowed with brain power, developed to the maximum by education and experience, capable of directing its affairs which are often more complicated and difficult correctly to administer than those of state government.

To make a watch requires a very large number of processes and many separate pieces of metal; for each process tools and machines have been devised and men have been trained to be skilful in the use of them. Men must buy the metal and the tools, sell the watches made, keep the factory in repair, keep records of cost, answer letters, secure money for payrolls, decide how many watches of each style shall be made far in advance of the time they will really be wanted. Each man must work in definite relation to the other or the desired result will not be attained; thus the relation of the men to each other, and to their tools and machines must be similar to the relation existing between the parts of the watch, even in spite of the fact that each is human and is endowed with feelings and human perversity. The fixing of these human relations to form the human machine called organization, is just as necessary in one kind of industry as another and applies universally to all individual establishments. Without organization there could be no effective or economic manufacturing or transportation. Organization is the result of attempts to reduce waste of human effort such as occurs when one man has to repeat the work of another or when one man opposes the efforts of another or when anyone is idle or fails to produce as much as he can. The systematic study of reduction of waste labor by management and organization is a comparatively recent thing, undertaken only after years of effort to reduce waste of energy in power machinery and waste of substances not in available forms. That men properly organized, trained, assisted and properly paid can produce effects enormously greater than could be produced by many times an equal number of individuals, especially when assisted by capital, is a basic proposition of the industries which was as slow to be learned as the lesson that nature's energy might be made to do man's work. It really seems as if the methods learned in applying nature's orderly laws controlling our generation of power and its application to machinery, are to be the means of teaching us how best to get along with each other, to work in common to produce desired results with least waste of anything and as effectively and harmoniously as do the parts of the presses that print our daily papers.

On pages 139 and 140 of the January 19, 1910, issue of POWER, we refer to a paper read in the fall of 1907 by Prof. H. F. Rugan and Prof. H. C. H. Carpenter before the Iron and Steel Institute, of London. The date referred to should be 1909. In the fourteenth line of the first paragraph the word hours should have been used instead of years, which of course would make some *slight* difference in the time interval referred to.

Dedication of Thurston Memorial Tablet

American Society of Mechanical Engineers Unveil Bronze Memorial Tablet Presented by Members in Commemoration of Their First President, Dr. Robert H. Thurston

On Tuesday evening, February 8, the New York monthly meeting of the American Society of Mechanical Engineers was devoted to the dedication of a bronze memorial tablet to Dr. Robert H. Thurston. The beautiful memorial, which was made possible through the generosity of members and their devotion to Doctor Thurston, was the work of Herman H. McNeil, a former student and personal friend of Doctor Thurston. It is a replica of the memorial tablet presented to Sibley College, Cornell University, by alumni and students. The program of the evening, reviewing the life work of Doctor Thurston, was divided under several heads, which were assigned to former friends and associates of the man.

Dr. Alex C. Humphreys, president of Stevens Institute of Technology and chairman for the evening, opened the exercises with a short address and was followed by John E. Sweet, who had been closely associated with Doctor Thurston in the organization of the society.

Doctor Thurston's Connection with the Society

Prof. John E. Sweet told the simply story of Doctor Thurston's connection with the society. His address, in part, follows:

To begin at the beginning—we must hark back to the fall of 1879 when the *American Machinist* was published in a small office at 96 Fulton street, New York City. The journal had been in existence but a few years, and had received contributions from a goodly number of contributors engaged in various branches of mechanical industries and from a wide section of the country. But very few of these contributors were known to the publishers, and fewer still to one another, and the notion came to my mind that it might not be a half bad idea to get as many of these contributors together as we well could, and give the publishers a surprise party, with a faint notion in my own mind that it might lead to an organization. I conveyed the notion of the surprise party to one of the contributors, and he at once gave it away to the editor, with the suggestion that some sort of a mechanical association be formed. The suggestion took root in the minds of the publishers, and Mr. Bailey, the editor, came up to Syracuse to see me about it, or, in fact, he came to inveigle me into writing the invitations; but, not being able to do that willingly, he made me do it any how. Among those invited were Alexander L. Holley and Prof. Robert H. Thurston, then in a sanitarium in Dansville, N. Y., both of whom entered heartily into the scheme, and invited many I did not know. Before the meeting, which was held on February 16, I came to New York, and Mr. Bailey and I had an interview with Mr. Holley, and each was to draw up some form of a program for the meeting, and meet the next day to compare notes. As such things usually turn out, Mr. Holley had drawn up a set of rules which were so complete that we could readily indorse them. At the meeting in the afternoon, there were something like thirty present, with letters of indorsement from fifteen or twenty others. Mr. Holley acted as

Bronze Tablet Dedicated to Dr. Robert H. Thurston

chairman. A good deal of time was spent in discussing the rules, which ended up by adopting those Mr. Holley had prepared, and, too, time was wasted in settling on a name, when Mr. Copeland said—"Call it 'The Society of Mechanical Engineers.'." This seemed to settle it, except in the shuffle the word "American" got incorporated, to the regret of possibly no one but myself.

Mr. Copeland, Charles T. Porter, Mr. Holley, E. D. Leavitt, Jr., and myself were chosen as a nominating committee. When the committee met it was found that the unanimous choice was for George H. Corliss for president. Mr. Corliss refusing, we tried William Sellers, who also declined for a much better reason, and, as Professor Thurston said later—"You couldn't get anyone to accept the presidency, so you hit upon me, a sick man, who could not help himself."

At what is now known as the first annual meeting held in New York City, November 4 and 5, Professor Thurston had regained his health, and was able to preside and deliver an able address.

Professor Thurston was elected president for the second time, and these two years were the critical ones in the society's history. Not only while president, but for a long time later, Doctor Thurston was more instrumental in helping up the society than any other man.

Doctor Thurston as a Naval Engineer

Following Professor Sweet's address, a communication from Benjamin F. Isherwood, United States engineer-in-chief of the navy, retired with rank of rear admiral, was read by Professor Hutton and was, in part, as follows: "My long and intimate personal acquaintance with Professor Thurston was intensified by our professional interest in the same subjects. His exceptionally valuable life was devoted to the improvement of the world in the only way in which it could, in his opinion be improved, namely, by the cultivation of physical science. Those who knew him best, valued him the highest and his death saddened all who knew him well enough to appreciate his gentle qualities as well as his lofty aspirations."

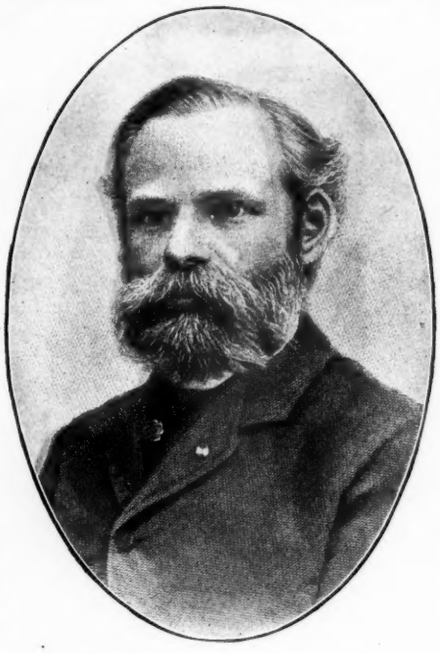
The next speaker on the program, Rear Admiral George W. Melville, retired, past-president of the American Society of Mechanical Engineers, was unable to attend. His address, outlining Doctor Thurston's work in the navy during the Civil war and his services at the naval academy at Annapolis, was read by Doctor Humphreys.

In July, 1861, Doctor Thurston entered the service and served at sea continuously until the close of the war, taking part in the battle of Port Royal and at the siege of Charleston. While still a second assistant engineer, he was placed in charge of the machinery on the "Chippewa" and later served on the monitor "Dictator" which was the largest built up to that time.

With his fine preliminary training at Brown University, backed up by four years of practical experience in the navy, it was obvious that Doctor Thurston was well equipped for duty as an instructor, and that was borne out by his remarkably good record at the academy.

Doctor Thurston at Stevens Institute

Col. E. A. Stevens, representative of the Stevens family, founders of Stevens Institute, spoke, in part, as follows: "The history of mechanical engineering in the United States will always bear witness to Doctor Thurston's ability, untiring energy and the liberality with which he



Dr. Robert H. Thurston

freely gave to his beloved profession all that his ripe experience and trained observation could give. Whatever may have been the value of his other work at Stevens, none of it equals in importance his share in the development of the system of instruction and the influence of his personality and his standard of professional ethics on those who were thrown in contact with him.

The true measure of his great work and usefulness is to be judged by the standard fixed by the great Master, 'By their fruits ye shall know them,' and the fruits of his work at Stevens are proved by the general high standing of the men who studied under him."

Doctor Thurston in Literature and in Research

In speaking on this topic William Kent said that his acquaintance with Doctor Thurston began near the end of the year 1874, when he called upon him to make arrangements for entering the junior class in Stevens Institute of Technology. Doctor Thurston was then 35 years of age and was professor of mechanical engineering, meeting his classes two hours a day. At the same time he was editing the four volumes of reports of the United States Commission to the Vienna exhibition of 1873, one of the volumes being written by himself; he had shortly before that written a report of the United States Commission for investigating the causes of steam-boiler explosions; he was now planning the researches to be made by the United States Board to Test Iron, Steel and Other Metals, of which he was secretary and the most active member. Besides all this he was writing papers for the American Society of Civil Engineers and for the *Journal* of the Franklin Institute, concerning the results of his researches.

In 1871 he had conducted a series of boiler tests on several different makes of water-tube boilers at the American Institute fair in New York. In 1873 he had organized a mechanical-engineering laboratory for the purpose of making engineering researches, the first of the kind to be established in the United States. About the same time he invented his well-known autographic testing machine for testing materials by torsion, and later he invented the machine for testing lubricants, in which some of the principles of the torsion machine were embodied.

Such intense mental activity as Doctor Thurston exhibited in these years led to its natural result, nervous exhaustion. There was a time in 1876 when he visited the institute only for a few minutes each day, and five minutes' conversation on any technical question would almost prostate him.

In 1873 Doctor Thurston discovered the phenomenon of the elevation of the elastic limit of iron and steel. It was also discovered independently in the same year by Commander L. A. Beardslee, U. S. N. In years following he tried to find other metals or alloys that exhibited the same peculiar action after being strained beyond their elastic limit, but never found one. In 1874 he investigated the burning of tanbark for fuel in specially constructed boiler furnaces, and in 1875 and 1876 he made a number of tests of steam boilers. For some years after 1876 he carried on investigations of lubricants, the results of which are in his book on "Friction and Lost Work." In later years his researches were not numerous or important, for the reason that his time was fully occupied with other work.

Doctor Thurston was an omnivorous reader, and a tremendously active writer. Prior to 1880 most of his technical writings were contributed to the American Society of Civil Engineers and to the *Journal* of the Franklin Institute. After that date his engineering papers were

mostly given to the American Society of Mechanical Engineers.

Doctor Thurston's literary work was not confined to engineering matters. In 1873 he contributed to the *Scientific American* a series of seventeen articles on his observations in Europe, which included not only what he had seen at the Vienna exhibition, and in the several iron works that he visited, but also his reflections on social conditions in the manufacturing centers.

Doctor Thurston's first important book after his report of the Vienna exhibition was his "History of the Growth of the Steam Engine," published by Appleton in 1878. It is written in his best style, and to those who are at all interested in the subject it is as readable as a novel. It illustrates his painstaking care to be sure of his facts, his skill in arranging them in logical order, and his good judgment in drawing conclusions. In 1877 he brought out a little book on "Steam Boiler Explosions in Theory and Practice."

In 1879 he had his second and last nervous breakdown, more serious than the first, so that he was compelled to spend more than a whole year in a sanitarium, doing no work of any kind. He returned to work in 1880, and then followed twelve years of most intense literary activity, during which he brought out an average of a book every year, some of them large octavos of 1000 pages each. Here is a list of the books whose first editions appeared in the years 1882 to 1894, inclusive: "The Materials of Engineering," three volumes: 1, "Non-metallic Materials"; 2, "Iron and Steel"; 3, "Brasses, Bronzes and other Alloys"; 'Text Book of Materials of Construction," "Treatise on Friction and Lost Work in Machinery and Millwork," "Manual of Steam Boilers, their Design, Construction and Operation," "Handbook of Engine nd Boiler Trials, the Indicator and the Prony Brake," translation of Sadi Carnot's "Reflections on the Motive Power of Heat and on Machines Fitted to Develop that Power," "Life of Robert Fulton," "Manual of the Steam Engine," two volumes: 1, "History, Structure and Theory"; 2, "Design, Construction and Operation"; "Stationary Steam Engines Simple and Compound," "The Animal as a Machine and Prime Motor, and the Laws of Energetics." Many of these books ran through several editions.

Doctor Thurston at Sibley College

Walter C. Kerr, director of Cornell University and president of Westinghouse, Church, Kerr & Co., recognized the impossibility of reviewing the full import of the eighteen years that Doctor Thurston devoted to Cornell University and limited his address to a few brief remarks on Doctor Thurston as an educator and organizer of rare talent, and also told how he was loved and respected at Cornell.

Lieut-Com. Robert Crawford and Chief Engineer, United States Navy, Charles H. Manning, had been invited to be present and deliver addresses, but both were unable to attend.

Rhode Island Coal

At a meeting of the New England section of the Society of Chemical Industry held at Boston on Friday evening, February 4, Henry M. Whitney and Henry J. Williams, respectively president and chemist of the Rhode Island Coal Company, spoke upon Rhode Island Coal and its Commercial Development.

Dr. W. H. Walker in introducing Mr. Whitney said that nature has not been kind to New England. She has endowed her with some water powers but left her to import the coal which is necessary to carry on her extensive industries. Mr. Whitney through his connection with the New England Gas and Coke Company was already identified with that fuel supply, and he would tell of his latest project for relieving New England's fuel necessities.

Mr. Whitney said that they had in Rhode Island control of four or five thousand acres of coal lands; that the coal was as good as the majority of Pennsylvania coal; that they did not claim that it was Franklin coal, but with treatment it burns with great freedom, intense heat and fulfils all the requirements of a good fuel.

They did not claim that it would go into competition with bituminous coal for use under boilers. It is more valuable for domestic purposes.

He said that they were preparing to build a breaker—indeed have begun it—and in the course of the next four or five months would be ready to produce coal, taking out inside of a year 1200 or 1500 tons a day. At the same time they were exploring with diamond drills and finding coal over a large area and in great thicknesses. As they go deeper the coal gets better and burns with more freedom. "There seems to be something in the treatment discovered by Mr. Williams which seems to impart to it the quality of easy ignition which was lacking in the coal from the upper levels. Many people are of the opinion that the coal will burn equally well without the treatment. That is a matter of experience and our experience has been that the treatment improves it."

It had been said that perhaps the company would establish a large power plant, but they have no immediate intention of doing anything of the kind. They should be abundantly satisfied if they could furnish coal for domestic purposes.

Mr. Whitney then read the following poem written by William Cullen Bryant in 1826:

A Meditation on Rhode Island Coal*

I sat beside the glowing grate, fresh heaped
With Newport coal, and as the flame grew bright
—The many-colored flame—and played and leaped,
I thought of rainbows and the northern light,
Moore's Lalla Rookh, the Treasury Report,
And other brilliant matters of the sort.

And last I thought of that fair isle which sent
The mineral fuel; on a summer day
I saw it once, with heat and travel spent,
And scratched by dwarf oaks in the hollow way;
Now dragged through sand, now jolted over stone—
A rugged road through rugged Tiverton.

I saw where fountains freshened the green land,
And where the pleasant road, from door to door,
With rows of cherry-trees on either hand,
Went wandering all that fertile region o'er—
Rogue's Island once—but when the rogues were dead,
Rhode Island was the name it took instead.

Dark anthracite! that reddenest on my hearth,
Thou in those island mines didst slumber long;
But now thou art come forth to move the earth,
And put to shame the men that mean thee wrong.
Thou shalt be coal of fire to those that hate thee,
And warm the shins of all that underrate thee.

Yea, they did wrong thee foully—they who mocked
Thy honest face, and said thou wouldst not burn;
Of hewing thee to chimney pieces talked
And grew profane—and swore in bitter scorn,
That men might to thy inner caves retire,
And there, unsinged, abide the day of fire.

For thou shalt forge vast railways, and shalt heat
The hissing rivers into steam, and drive
Huge masses from thy mines, on iron feet,
Walking their steady way, as if alive,
Northward, till everlasting ice besets thee,
And sought as far as the grim Spaniard lets thee.

Thou shalt make mighty engines swim the sea,
Like its own monsters—boats that for a guinea
Will take a man to Havre—and shalt be
The moving soul of many a spinning-jenny,
And ply thy shuttles, till a bard can wear
As good a suit of broadcloth as the mayor.

*From Poems by William Cullen Bryant.

Mr. Williams' paper and the discussion will appear in another issue.

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February 15	35,000

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Rhode Island Coal

John Fulton in his book upon "Coke" says: "The extreme eastern anthracite field lying mainly in Rhode Island, with its north end resting in Massachusetts, contains about five hundred square miles of coal measures.

"In northeastern Pennsylvania the triple anthracite coalfields cover an aggregate area of 485 square miles. The smaller anthracite field in Sullivan county, Penn., with detached patches in Maryland, West Virginia, Colorado and New Mexico, cover an aggregate area of twenty-five square miles."

Rhode Island coal has been known for a long time. William Cullen Bryant "meditated" upon it in 1826, and although it is apparent from his poem that the old joke of taking to the coal mines to escape the all-devouring fire of the judgment day because they would be the last thing on earth to burn was then not even in its youth, he eulogizes its long-flaming qualities and directs his prophetic vision at the industrial wonders which it is to perform.

Several attempts have been made to mine the coal commercially but they have failed because it was so hard that it required more kindling and trouble to ignite it and more attention and watchfulness to keep it going than other coals available without compensating advantages even in price. It has a trick of going out while one's back is turned; but it can be burned if one gives it draft enough and handles it right. With Pennsylvania anthracite getting up toward ten dollars it may be that people will put up with the additional trouble of burning this harder fuel if it can be offered at a sufficiently lower price.

Our interest in the present attempt to exploit it lay in its possibilities as an industrial fuel, to the promise of which some of the newspaper accounts of the project pointed. This phase of the question has been definitely settled for the time being by the declaration of H. M. Whitney, the president of the company, that they have no present intention of offering the coal for industrial purposes or of establishing a large power plant, the coal being more valuable for domestic use.

Mr. Williams, the chemist of the company, resented, in his remarks before the New England Section of the Society of Chemical Industry, the skepticism which had been manifested in certain quarters with regard to the project and said that they were simply going along about their business getting ready to mine coal and sell it and that the public had simply "butted in." With the stock upon the Curb and a statement in a prospectus issued only last summer that 400,000 shares were available at ten dollars per share, the public has a genuine interest in the *bona fides* of the venture.

Another feature of the scheme which interests us profoundly is the claim that by the immersion of the coal in a bath containing three pounds of calcium chloride to a ton of the material, it is changed from an impracticable to an ideal fuel. Mr. Williams, who is no charlatan but a chemist of repute, offers an explanation of this action which is considered in the editorial following, Chemical Aids to Combustion. We should be glad to have the opinions of other chemists as to the reasonableness of the explanation, and to have reports from those who may try the chemical upon anthracite or other coal. The demonstration that it is an efficient aid to combustion, whatever the explanation or without any explanation, would be of immense interest and value to all users of coal; but the demonstration, although promised months ago, has not yet been made to our satisfaction.

Chemical Aids to Combustion

So many things work that ought not to work and so many things don't work that ought to work—*John Sweet.*

We have commented upon many aids to combustion, Kem-Kom, the "Cobbler's Mixture" of salt and oxalic acid, and lastly the Bloss solution of Chile saltpeter with which it was proposed to make the hard graphitic coal of Rhode Island practicable for ordinary use. In treating of this latter we showed that enough of the chemical to furnish oxygen to burn one-twentieth of the coal would cost something over ten dollars per ton.

Henry M. Whitney, who has undertaken the exploitation of Rhode Island coal (chemically treated to render it free-burning), takes exception to this statement as unfair, claiming that the coal is being treated at a cost of a few cents per ton. Henry J. Williams, the chemist of the Rhode Island Coal Company, of which Mr. Whitney is president, and patentee of the process which they purpose using, admits that our figures would be correct if the chemical were depended upon to furnish oxygen, but denies that this is the case. As a matter of fact, he claims, they get better results by the use of calcium chloride,

which contains no oxygen, than they do with the saltpeter.

His explanation of the action of the chemical, if true, places the whole subject of chemical aids to combustion in a new light.

According to Mr. Williams the action is a catalytic one. By catalysis the chemist means the bringing about, by the mere presence of a substance, of an action into which the substance does not enter or, at least, which leaves it unchanged. Such an action is the decomposition of substances by the presence of finely divided metals like platinum or colloidal nickel; the rapid evolution of oxygen from potassium chlorate when a small quantity of manganese dioxide is present, the solution of insoluble chromic chloride through the mere presence of chromono chloride; the saponification of fats, etc.

In Mr. Williams' process the coal is thoroughly wet with a solution in water of calcium chloride, about three pounds of the chemical being used to one ton of coal. When the solution dries each morsel of the coal is coated with a thin deposit of the chemical. We do not know what the action is supposed to be with the calcium chloride, but Mr. Williams in one of his patents outlines the possible action with the Chile saltpeter as follows:

Two molecules of the saltpeter decompose by heat in the presence of hot carbon as follows:

$$\frac{NaNO_3}{NaNO_3} = Na_2O + N_2 + O_5.$$

The nitrogen and oxygen escape up the chimney; the latter in combination with carbon from the fuel, and this is all of the direct contribution of the chemical to the combustion. There is left the Na_2O which Mr. Williams conceives to act as follows, the H_2O coming from the moisture in the fuel or air.

$$Na_2O + H_2O = 2\,NaOH \qquad (1)$$

Taking CO_2 from the combustion of the fuel this becomes

$$2\,NaOH + CO_2 = Na_2CO_3 \qquad (2)$$

the two atoms of hydrogen combining with one of the oxygen to reform water vapor and escape with the products of combustion.

This sodium carbonate in the presence of even graphitic carbon at 1200 to 1800 degrees Fahrenheit picks up another atom of carbon and becomes

$$Na_2CO_3 + C = Na_2O + 2\,CO \qquad (3)$$

the last term being two molecules of carbon monoxide which burns with oxygen from the draft and goes off to the chimney, leaving one molecule of Na_2O (sodium oxide), which is nonvolatile and is the permanent contribution of the medium to the furnace. The little which has so far been done in making combustible gas at the expense of the chemical has been done at too great a cost, as our former editorial pointed out; but Mr. Williams claims that by far the more important service is rendered by the residue which he conceives as acting catalytically as follows: The oxygen in the atmosphere is not in the form of isolated atoms but in molecules composed of pairs of oxygen atoms. Notwithstanding the strong affinity of carbon for oxygen it cannot separate the pairs of oxygen atoms and appropriate the oxygen from the atmosphere so easily as it can take the atom of oxygen away from the sodium, and the sodium although it cannot keep the atom of oxygen from the carbon after it has got it, can get another one from the atmosphere while the carbon cannot. So the sodium goes on pulling oxygen out of the atmosphere and passing it along to the carbon, which would otherwise get it with difficulty, and making of this almost graphite carbon a free-burning coal.

We do not know what there may be in this. As Uncle Remus says, "As de tale was gun ter me, so I gives it to you."

The editor of POWER arranged a meeting between Mr. Williams and Dr. Augustus H. Gill, of the Massachusetts Institute of Technology, for the discussion of this hypothesis, which resulted in an adjournment to Doctor Gill's laboratory where the following experiment was performed: Mr. Williams announced that by means of this same supposed catalytic action he proposed to burn pure graphite, and a small amount of the flake variety was put into a platinum crucible covered with sodium carbonate and heated in a bunsen burner. Each time the cover was removed from the crucible there was an ignition of gas with which the crucible was filled. The explanation was that carbon even in the hard, amorphous form of graphite was reduced by this catalytic process to the combustible monoxide gas.

The next day Mr. Williams, Doctor Gill and the writer went to Portsmouth, R. I., where the coal mine is located, and saw something, said to be treated coal from the local mine, burning very satisfactorily in the depot stove and in the parlor and kitchen stoves of a boarding house. This, however, was hardly a convincing demonstration, and there were all sorts of difficulties found to be in the way of allowing us to see a new fire built of untreated coal. It was finally arranged that such a test should be made the next week at Boston. This was on October 20 and the difficulties surrounding the case have been such as to preclude its being made even unto this writing.

If there is such wondrous virtue in calcium chloride it would seem to be easy to demonstrate and if, as Mr. Williams says, it will render ordinary anthracite more free burning and efficient and will make soft coal burn without smoke "if you only keep the furnace temperature up to that required for the reaction" it would seem to be worth demonstrating. Mr. Williams does not seem anxious to have it tried. His excuse for not substituting a fire of untreated coal for that shown our editor at the depot was that there would probably be enough of the chemical left in the stove lining to carry on the reaction and make it appear that the coal burned as well without as with the mixture. It was related that in one of their tests coal treated with the solution and with an equal amount of clear water burned with apparently the same freedom, which was very disconcerting to the patentee of the process until it was remembered that the pail that was used to dip the plain water was that which had been used for the solution, and that enough of the traces of the chemical had probably lingered around it to effect the result. There are many other substances which will produce it, some of which are contained in the coal itself, and if he gives us a sample to test or tests a sample in our presence, treated and untreated, the expected difference may not develop and we may be confirmed in the skeptical attitude which we have assumed.

This easily demonstrable action remains, therefore, to be demonstrated to our satisfaction, and if the success of this new effort to put Rhode Island coal upon the market depends upon the treatment, we should have to see the virtue of such treatment proved more positively than it has yet been to our knowledge before advising one to interest himself in it.

At a recent meeting of the Leeds University Engineering Society, M. Sykes contributed a paper on "The Setting of Steam Boilers." He remarked upon the almost complete absence of textbook reference to boiler setting, and the tendency to leave the matter to any bricklayer. He pointed out that the correct setting of boilers contributes largely to their economy and efficiency, and was therefore a matter of importance. Leakage of cold air into flues, and conduction and radiation of heat through brickwork were fruitful causes of waste. Short-circuiting of the flue gases should be guarded against, and sharp corners and sudden curves avoided. Care should be taken that all rivets and joints are either open to inspection or that they can be easily uncovered and recovered. Broad surfaces of brickwork in contact with the boiler should be avoided, as they tend to shorten its life through corrosion. Downtakes are best covered with iron frames and plates, with manholes or soot doors. Swivel dampers admit a minimum of air, but where slide dampers are employed a brickwork sleeve may be built above the flues, covered at the top by a flag or iron plate, through which the actuating rope or chain can pass.

NEW·POWER·HOUSE·EQUIPMENT

What the Inventor and the Manufacturer are doing to save time and money in the Engine room and Power house

New Type of Feed Water Heater

The Harrison Safety Boiler Works, Seventeenth and Clearfield streets, Philadelphia, Penn., recently brought out an improved type of heater and receiver, combined with an extra-large separator and fitted with valves so arranged that the separator can remain in service while the heater itself is cut out for inspection or cleaning. This combined apparatus replaces a considerable amount of apparatus, and saves a corresponding amount of space in boiler rooms where there is not much headroom. This horizontal, cylindrical form, fitted with the surplus exhaust or steam-stack type of separator, as shown in Fig. 1, is used.

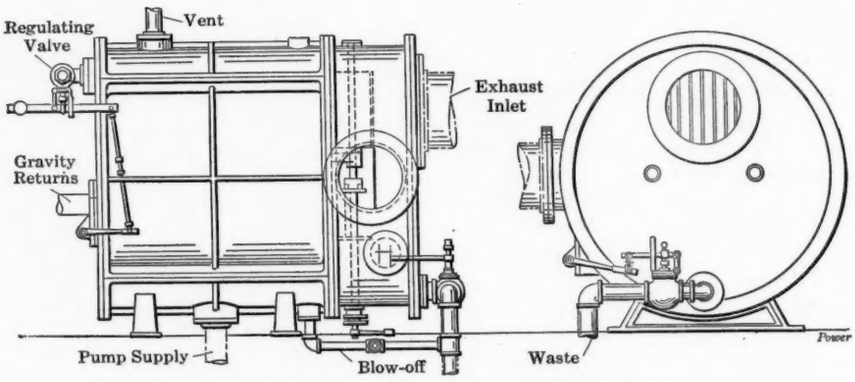


FIG. 1. HORIZONTAL TYPE HEATER AND RECEIVER

The steam stack is not at the top of the separator, as is ordinarily the case, but extends from the side, still further reducing the amount of headroom required. The separator covers the whole end of the heater. The separator and the drainage trap, which disposes of the drips from the separator and of the overflow from the heater, are both contained within the ring casting at the end of the heater, the shell of the heater being constructed something like that of a cylindrical surface condenser. A circular plate closes the end of the heater body proper and contains the port through which the steam enters the heater, and the opening through which the waste from the heater overflow, or skimming weir, escapes into the trap. The separator ring is bolted fast against the plate. At one side of the separator casting is the surplus exhaust outlet, and below is the stuffing box for the lever, to which is attached the float that operates the valve draining the trap.

Two semi-cylindrical valves, on a common spindle, serve to close the steam opening simultaneously, and thus to shut the separator off from the body of the heater when the latter is to be opened for cleaning or inspection while the heating system remains in operation. At the top of the spindle is a handle swinging horizontally over the top of the heater shell. The separator baffle plate, which serves to arrest the particles of oil and moisture carried by the current of exhaust steam entering the separator, is attached to the front cover plate of the separator, the steam passing around one side and then behind the baffle. When the steam valve is open, the steam is deflected into the heater, the remainder of the exhaust steam passing to the surplus exhaust outlet.

At the opposite end of the heater shell are the cold-water inlet and the float mechanism controlling the flow, according to the level of the water in the heater. The opening for gravity returns is also at this end, as is the door for removing the trays over which the water is sprayed in the top of the heater, and the door for removing precipitated impurities and filtering material from the bottom part of the settling chamber.

The heater and receiver, shown in Figs. 2 and 3, differ from the heater described above in that the exhaust outlet is at the top of the separator ring, and the valves are arranged on horizontal spindles connected to a common valve gear and handle, and the float controlling the cold-water inlet valve is attached to a spindle passing in through the main heater shell instead of through the rear-end plate.

The principal feature of interest about this heater is the use to which it has been put. It is installed between a steam engine and an absorption refrig-

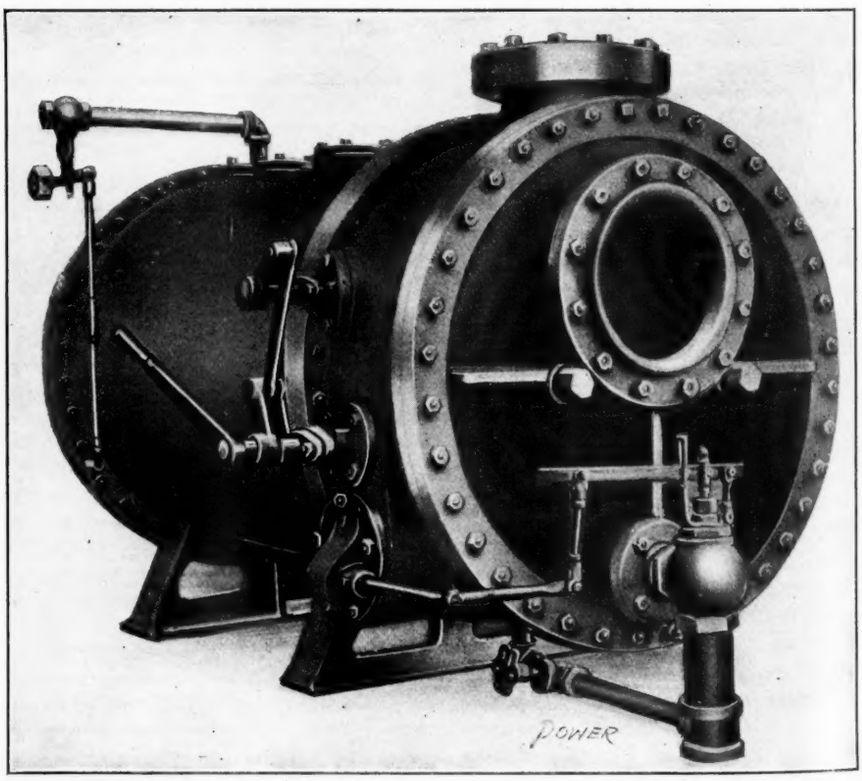


FIG. 2. HEATER AND SEPARATOR, SHOWING VALVE-CONTROLLING GEAR

erating machine, purifying the exhaust steam of oil as the latter passes to the refrigerating machine and receiving the condensed returns from the latter and such make-up water as may be required, and heating the same up to 210 degrees Fahrenheit for boiler feed. In order to be able to operate the ammonia generator at any desired pressure, the heater has been made with a solid shell to withstand a maximum pressure of 40 pounds.

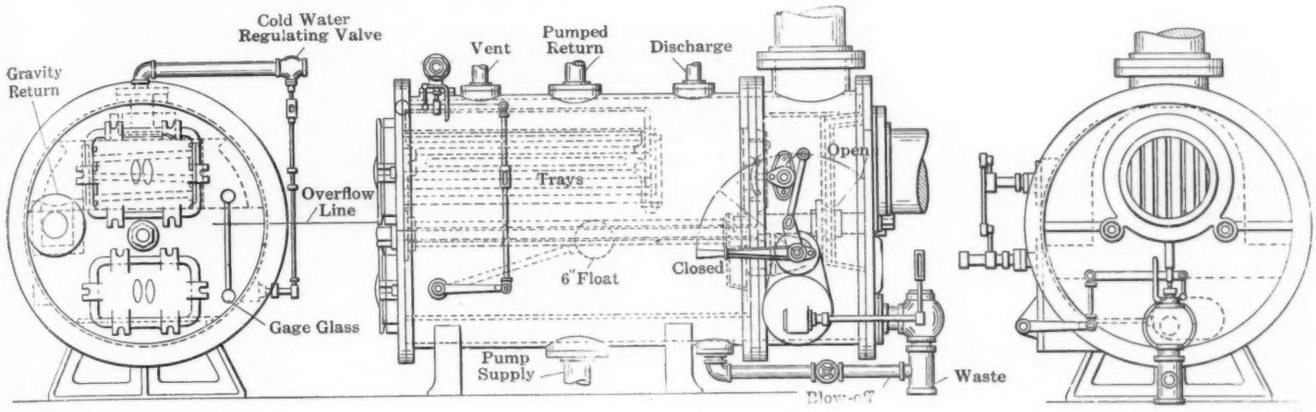


FIG. 3. ANOTHER DESIGN OF HORIZONTAL HEATER AND RECEIVER

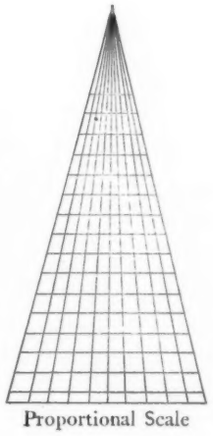
An Area Measuring Instrument

The areameter, as it is called, is a device for measuring areas. It consists of a "set square" made of transparent celluloid, having two of its sides formed to a hyperbolic curve, the proportion being such that any triangle is one square inch in area, which for any given hight has at the same time a base equal to the width of the set square at the given hight from the base. This is shown in *A*, where the base line is regular, but the upper line irregular, the higher the upper line from the base line the smaller the division, while they are larger as the upper line of the diagram approaches the base line, as shown at the right of *A;* the area of each division, however, being the same.

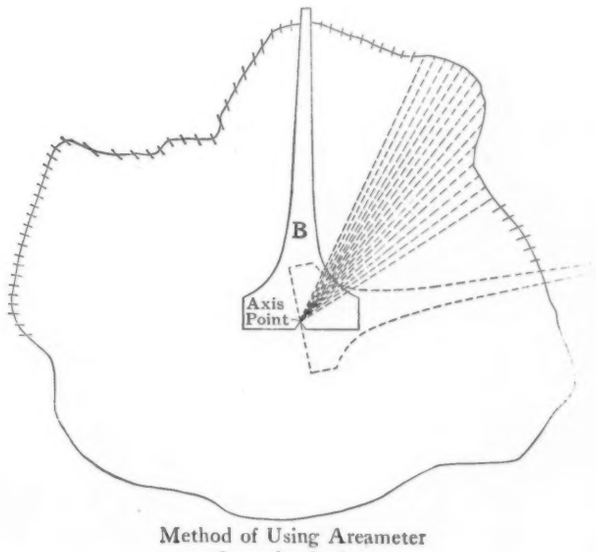
When measuring an area with a straight base and perpendicular sides, the top only being curved, as shown in *A*, the areameter "set" is placed so that the axis point can move on the base line along a straight edge. Starting at either end of the curve, the point where the areameter blade cuts the line of the figure being measured is marked by a pencil. The instrument is then moved forward to make a second pencil mark, and so on, until the whole of the area is divided. Then, according to the scale of the instrument, the area can be determined by counting the number of division marks.

In case of an irregular area, such as when taken to the center. It is not, however, necessary to join the points to the center as shown in the illustration. It will be noted that in this case triangles, not rectangles, are divided off; and the instrument constant will therefore be one-half that for the appliance when used as shown in *A*.

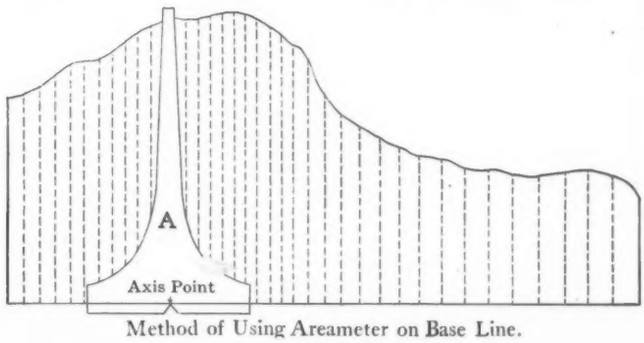
The area will not always exactly divide by the instrument, and the space left must be measured as a decimal part of the average width of the divisions on each side of it. This average width is determined by means of dividers, which are moved along a proportional scale on the instrument, but shown separate in the illustration, until the divider width is reached. This is marked with a pencil and the remaining part on the curve is taken with the dividers, and applied to the scale at the same point.



Proportional Scale



Method of Using Areameter on Irregular Surfaces.



Method of Using Areameter on Base Line.

METHODS OF USING THE AREAMETER

and read off as a decimal. As an example, suppose *B* represents a plot drawn one-eighth full size. With the instrument giving a ½ square inch triangle area, if the area is divided into 125 parts plus a remainder, which is 0.4 of the average width of the divisions on each side, the actual area of the figure drawn would be

$125.4 \times ½ = 62.7$ *square inches,*

and the area of the plot itself will be

$62.7 \times 64 = 4012.8$ *square inches.*

This instrument is manufactured by Albert E. Mallandain, 51 Cheapside, London, E. C., England.

Foster Rocking Grate

The Foster rocking grate is manufactured by the F. W. Foster Manufacturing Company, 99 Haverhill street, Boston, Mass.

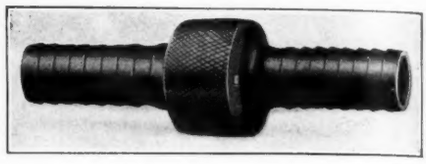
These grates are made to withstand heavy firing with different air openings for the different grades of fuel. They may stand on their own legs, independent of the boiler setting, or may be placed on bearer bars if preferred. They have graduated air spaces and it is said that they will not warp or bind, ample provision having been made for expansion. The bars are securely locked, at both ends, to the frame by a simple device, and are easily removed. They operate easily without friction and are said not to clog or stick when shaken. The bars and other parts are interchangeable, and are made from iron patterns, thus assuring exact duplicates of the original in case repair parts are needed.

The grates are so designed that they can be operated through the ashpit doors or through the boiler front. The operation is simple, as by a simple movement of a shaker handle the ashes are removed and the fire kept bright and clean. The bars are kept in a level position and are locked by the removal of the shaker handle, leaving no fingers in the fire to burn off. Figs. 1 and 2 show the open and closed position of the grates. Fig. 3 shows the general design of the grate used with upright boilers.

Pneumatic Hose Coupling

This coupling is claimed to be a strictly nonleakable hose coupling with a swivel joint, which prevents kinking the hose. It is said to be perfectly tight under any pressure, the principle being that it is packed by pressure.

A spring keeps it securely locked, and jarring will not open it, thus eliminating



PNEUMATIC HOSE COUPLING

a source of trouble, and there are no gaskets to blow out.

The coupling is so designed that there is no reduction in area, the coupling having the same size opening as the hose. It is made in several sizes, by the Caskey Valve Company, 99 John street, New York City.

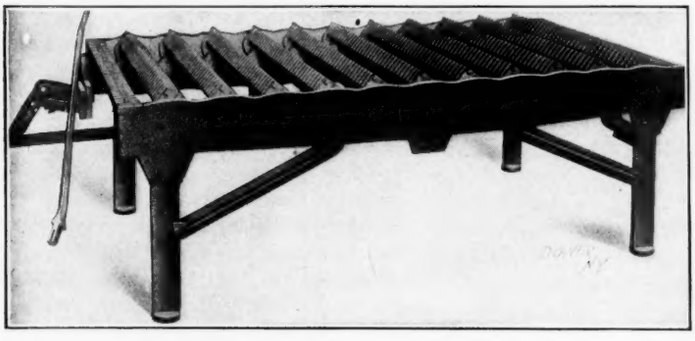


FIG. 1. GRATES OPEN

FIG. 2. GRATES CLOSED

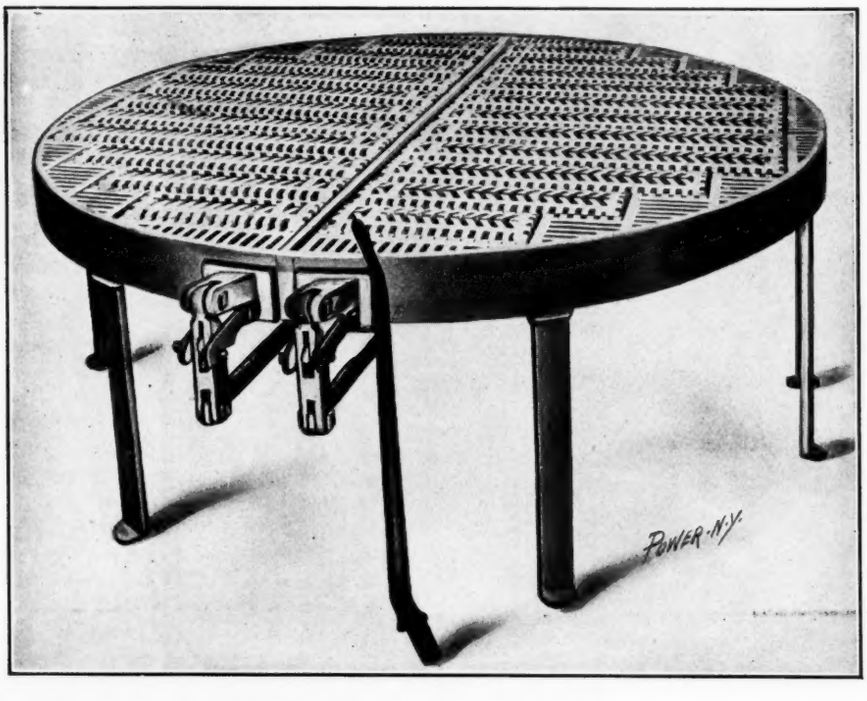


FIG. 3. GRATE FOR VERTICAL BOILER

Laminated Construction in Leather Belting

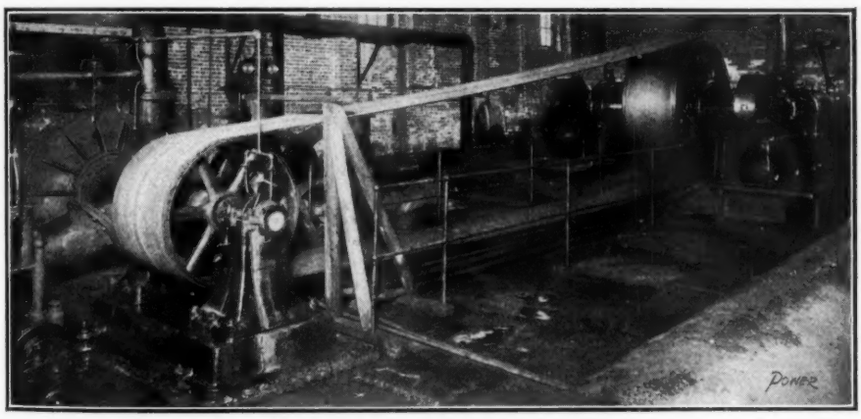
BY A. EUGENE MICHEL

Economy in transmitting power by belted drives depends first of all upon the flexibility of the belting and the smoothness of its surface. If the belt is stiff and hard either internally or on the contact surface it cannot be expected to wrap around the pulleys closely as it must to prevent slip.

Surface smoothness in a multilap belt is dependent upon placing the grain or hair side of the leather to the outside and in an ordinary single belt by placing this next to the pulley. Yet the grain surface is the weakest part of the leather, being the first to be injured by improper tannage, the first that will burn from slippage of a belt on its pulleys, and the part that is likely to be ripped off in patches by sticky belt dressing.

The steady pounding which this surface naturally receives with every pulley contact tends to make it hard and brittle until as the amount of slip increases, the outside leather burns and leaves the interior of the belt open to gradual deterioration.

The fibers of leather are mostly parallel to the surface, and when brought into sidewise contact with the pulley as they must be in ordinary belting, the effect might well be compared to that of daily traffic on wood-paving blocks laid with grain parallel to the street. In the latter instance, the wood would splinter to destruction in no time, but when placed to receive the blows against the ends of the fibers, the continual pounding does no damage. Similarly a butcher's block with the grain parallel to the top would be ruined in a hurry. The fibers in belting are affected or rather unaffected in much the same way when the pressure comes end-on. This is precisely the condition which is brought about in laminated belting. The leather strips or laminations, all of equal cross-section, are bound side by side without cement and so placed that the cut edge of the leather forms the belt surface.



LAMINATED-BELT INSTALLATION

The leather is not only longer lived and more flexible when so placed but by reason of the fibers being better able to retain their natural dense interwoven position, they seat themselves more firmly against the pulley surface, cling better and permit the belt to transmit a far greater percentage of the power.

The advantages of bringing the cut edge of the leather into contact with the pulley, as compared to using it in the ordinary way, are strikingly shown by an experience of the Standard Oil Company with one of the belts in their Eagle plant at Jersey City. In this plant, which is their largest refinery of lubricating oils, the condenser water is circulated by a 16,000,000-gallon centrifugal pump which in turn is belt driven from a 500-horsepower Fleming-Harrisburg engine. The driving pulley is 90 inches in diameter, the driven 42 inches and the distance between centers is 28 feet, 2 inches. As first installed, a 32-inch three-ply ordinary leather belt strengthened by a 24-inch three-ply rider were employed to drive the pump. In justice to this outfit, it must be stated that the varying temperatures and moisture in the plant are very severe on flat-lapped belting. Trouble was experienced with the belting almost from the beginning, and as the stretching of the leather continued, the belt slip increased until by actual test the power loss was over 20 per cent. The driven-pulley face overheated to such an extent that shutdowns were necessary at various times during the day. Belt dressings were tried but offered nothing more than a temporary relief. So much dressing was used that on hot days it would ooze out of the belt and cause an all-day shutdown, during which the auxiliary pumps had to be used. To make matters worse, the plies of both belts parted, due probably to the surrounding moisture, and the belts had to be sent back to their manufacturer for regluing.

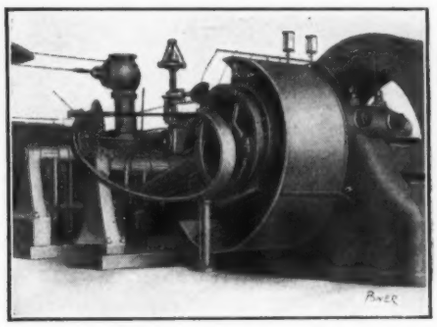
There had been no stinting of price in buying these belts. On the contrary, every effort had been made to get the best, and when the trouble had reached the stages mentioned, the Standard Oil Company was about decided that the only remedy was to remove the entire installation and replace it with a direct-connected outfit.

Before doing this, however, it was proposed to try laminated belting, and the drive was equipped with an Albeco laminated belt made by the American Laminated Belting Company, of New York. This drive is shown in the illustration. The belt is 28 inches wide, and equivalent in thickness to a three-ply lapped belt. The results are of more than passing interest. The power loss now from belt slip is hardly perceptible. The pump when driven by the old belts would lose its suction if the steam pressure fell below 85 pounds, while with the Albeco laminated belt the pump can be operated with as low as 65 pounds of steam. The laminated belt has never been taken up nor has it required other attention. It is doing with 21 square inches cross-section of leather what could not be done by six plies of the best leather of about 39 square inches cross-section. The laminated belt has never deviated more than one-fourth inch from its true position on the pulleys.

The stout guard of 2x4-inch timbers shown near the pump in the illustration had to be used with the lapped belts to keep them from going over the side of the driven pulley when full load was thrown on, and at other times as well. The guard on the far side was faced with leather 3 inches deep, but in the natural course of running the edge of the lapped belt cut through this clear down to the wood in several months' time. The guard was left in place when the laminated belt was installed, thinking it might be needed, but so far it has had nothing to do.

Chain Governor Drive

The William Tod Company, Youngstown, O., makes a machine-cut chain and sprocket governor drive and by an arrangement of sprockets, shafting and bevel gears a positive speed ratio is maintained between the main and governor shafts.



CHAIN-DRIVEN GOVERNOR

In the illustration, the outboard bearing, flywheel, main shaft, driving sprockets and the chains are removed to show the governing mechanism to better advantage. The position of the chains in service is indicated by that of the chain guard. It will be noticed from the double-driven sprocket and the width of the chain guard that two chains are used.

These are of the standard roller type and are made by the Diamond Chain and Manufacturing Company, Indianapolis, Ind. A single chain transmits sufficient power to drive the governor shaft, but the second chain is added so that one chain will always be working in case of an accident to the other.

Annual Banquet of Atlantic City No. 4

The thirteenth annual banquet of Atlantic City Council, No. 4, of the American Order of Steam Engineers, was held at the Royal Palace hotel, Atlantic City, N. J., on Saturday evening, February 5. A palatable dinner was served to about one hundred and fifty members and guests, among them being many persons prominent in the organization, as well as several of the leading citizens of the city. Mayor F. B. Stoy has attended all of the thirteen dinners given by No. 4, and his remarks on this occasion were listened to with interest. Brief addresses were made by N. C. Evans, William LeCompte, Charles Carpenter, Frank Martin, Harry Kruth, H. Heilman and H. J. McConnaughy. Each of the speakers dwelt upon the splendid work the association is accomplishing, and predicted a rapid growth. "Billy" Murray entertained with several popular songs and "Jack" Armour told stories and recited. John A. Best made the best of toastmasters. The committee responsible for the success of the occasion were: W. Scott Price, John A. Best, C. F. Noble, J. W. Frampton and A. H. Franks.

The absence, due to sickness, of T. Duncan Just, managing editor of *The American Journal*, and Charles A. Hopper, president of the American Supply Men's Association, was greatly regretted by the entire body, who rose as a unit in voting to send telegrams of regret to the ailing ones.

SOCIETY NOTES

The twenty-fifth anniversary, entertainment and reception of Newark Association, No. 3, N. A. S. E., of Newark, N. J., was held at the New Auditorium on Friday evening, February 4. The members and friends of the organization, numbering about one thousand, enjoyed the performance, and danced until a late hour. The hall was specially decorated for this occasion. Refreshments were served after the dancing.

On Tuesday evening, January 18, a ladies' night was held at Eagle hall, by the N. A. S. E. Local No. 1, of Richmond, Va. The wives of members and of other engineers were invited for the purpose of demonstrating to them the advantages of the N. A. S. E., so that they would encourage the men to attend meetings, or to become members, if not already enrolled. A number of interesting addresses, songs and recitations were rendered by members, and the evening was generally voted a success.

The eighth annual entertainment and reception of Hoboken Association, No. 5, N. A. S. E., of Hoboken, N. J., took place at Odd Fellows' hall, on Monday evening, February 7. The attendance was up to the usual standard. An enjoyable entertainment was given after which the floor was cleared for dancing, and notwithstanding the crowded condition of the hall a happy night was spent. The committee of arrangements included James J. Durkin, Thomas J. Baker, James C. Clark, Thomas R. Brennan and Gustave Ehlers.

The local members of the A. S. M. E., of Boston, will hold their March meeting in room 6, Lowell building, Massachusetts Institute of Technology, on Friday evening, March 11, at 8 o'clock. This will be a joint meeting with the Boston section of the A. I. E. E. M. W. Alexander, of Lynn, will read a paper on "The Training of Men—A Necessary Part of a Modern Factory System." This paper describes in some detail the work the General Electric Company is doing at Lynn in the way of training young men to become shop foremen, superintendents, and to take other responsible positions in that company, and should be of interest to engineers generally.

Wednesday evening, February 2, Illinois No. 1, of Chicago, gave another of its popular vaudeville entertainments, and although the weather was unfavorable the hall was packed to the doors with members, friends and their ladies, the affair proving highly successful in every respect. The program included the following numbers: O. J. Cloer, C. W. Hitchcock and W. S. Pardy in the Harmony Trio; E. J. Soner, banjo soloist; Redman T. Hogan, monologue and songs and Miss Anderson, also with monologue and songs. Music was furnished by the West Side orchestra under the direction of Bismarck King. Dancing followed the entertainment. An invitation had been

BANQUET OF AMERICAN ORDER OF STEAM ENGINEERS AT ATLANTIC CITY

extended to all other associations and many members of Nos. 2, 28 and 38 were present.

Russell Klemm opened the informal discussion on the "Calculation of Condenser Sizes for Economical Operation" which took place in the lecture room of the Modern Science Club, Brooklyn, N. Y., on Tuesday evening, February 1. Members and guests joined in the animated discussion which followed the opening, Mr. Orrok putting several original formulas relating to cooling surface, tube lengths and circulating water on the blackboard. After several others had spoken, the discussion was closed by Mr. Johnson who treated the subject from the viewpoint of the operating engineer, and said among other things, in referring to the formulas, that the man who would use such hieroglyphics to find out what results he was getting, ought to be ashamed to look in the face of an honest condenser.

The Chanute medal, which is each year awarded by the Western Society of Engineers for the best paper presented to the society in the field of civil engineering during the preceding year, has been given to Prof. Arthur N. Talbot, of the University of Illinois. Professor Talbot's paper, which has been made the basis of the award, is entitled "Tests of Cast-iron and Reinforced Concrete Culvert Pipe," and describes an elaborate research which in its various stages has been in progress for a number of years at the University of Illinois. The foundation for the medal given by the Western Society of Engineers was established by Dr. Octave Chanute. The arrangement provides for three medals, one for work in the line of mechanical engineering, one in civil engineering, and one in electrical engineering. Professor Talbot's friends are congratulating him upon being the recipient of so distinguished an honor.

The eighth annual reception and banquet of the combined associations of the National Association of Stationary Engineers, of Greater Pittsburg, was held on Thursday evening, February 3, at the Monongahela house. Every seat at the tables was occupied, and more than half of them by ladies. Fred Raven, the national secretary, from Chicago, was present, and also many other prominent persons in the engineering world, besides delegations from nearby cities. After partaking of the appetizing collation, the company adjourned to the dancing parlor, where an entertainment was given by Frank Corbett, of the Aschroft Manufacturing Company; "Billy" Murray and Joe McKenna, of Jenkins Brothers, and J. C. Ussher, of the Crandall Packing Company. At the close of the entertainment dancing was kept up until the early morning.

NEW INVENTIONS

ENGINES, TURBINES AND MOTORS

ELASTIC FLUID TURBINE. Charles G. Curtis, New York, N. Y., assignor to General Electric Company, a Corporation of New York. 945,919.

STEAM ENGINE. Edwin J. Armstrong, Erie, Penn., assignor to Ball Engine Company, Erie, Penn., a Corporation of Pennsylvania. 946,094.

INTERNAL-COMBUSTION ENGINE. Frederick G. Hatch, Glasgow, Scotland, assignor to the Anderston Foundry Company, Ltd., Glasgow, Scotland. 945,233.

EXPLOSION ENGINE. Heinrich Sohnlein, Wiesbaden, Germany. 946,406.

INTERNAL-COMBUSTION ENGINE. Sherren B. D. Harding, London, England. 945,232.

INTERNAL-COMBUSTION ENGINE. Abbot A. Low, Horseshoe, and Harry Hertzberg, New York, N. Y.; said Hertzberg assignor to said Low. 946,239.

INTERNAL-COMBUSTION ENGINE. Henry H. Simon, Atlanta, Ga. 946,158.

WATER-MOTOR. Amiel Bratschie, New Castle, Penn. 945,746.

ROTARY ENGINE. William W. Wheeler, Meriden, Conn. 945,067.

PIPING, VALVES AND TOOLS

PIPE COUPLING. John E. Ward, New York, N. Y., assignor to Ward Equipment Company, New York, N. Y., a Corporation of New York. 945,298.

VALVE. Everett P. Allen, Chicago, Ill., assignor to Norwall Manufacturing Company, Chicago, Ill. 945,433.

SAFETY DEVICE FOR PIPING. Johann Koenig, Riga, Russia, assignor to one-half to Emil Witzenmann, Pforzheim, Germany. 945,552.

VALVE. Joseph P. Lavigne, Detroit, Mich. 945,556.

FLEXIBLE PIPE JOINT. Albert G. Elvin, Franklin, Penn. 946,025.

COMBINED PIPE WRENCH AND CUTTER. Gary G. Brown, Roseburg, Ore. 946,103.

PIPE TONGS. James A. Gillespie and Marvin J. Corey, Coalinga, Cal. 946,506.

BOILERS, FURNACES AND APPLIANCES

AUTOMATIC DRAFT REGULATOR FOR FURNACES. Herman F. Westphal, Milwaukee, Wis. 945,831.

METHOD OF CONTROLLING COMBUSTION IN FURNACES. George Bruce, Toronto, Ontario, Canada. 945,443.

METHOD OF BURNING POWDERED COAL. Louis S. Hughes, Joplin, Mo. 945,846.

MECHANICAL STOKER. Henry J. C. Gieseke, Jersey City, N. J. 945,322.

FURNACE. Alois Schmidt, St. Paul, Minn. 945,869.

OIL BURNER. Harry B. Stilz, Bath, Me. 945,873.

HYDROCARBON INJECTOR BURNER. Emygde J. Achee, Bayou Goula, La. 945,899.

OIL BURNER. Holmes Duke, Beaumont, Texas. 945,922.

VAPOR BURNER. Herschel M. Conner, Chicago, Ill., assignor of one-half to Willis A. Burney, Jr., Savannah, Ga. 945,305.

OIL BURNER. Julius A. Mahr, Minneapolis, Minn. 945,967.

PRESSURE BURNER WITH COMPRESSING MIXING PIPE. Carl E. Andersson, Eskilstuna, Sweden, assignor to Aktiebolaget Eskilstuna Separator, Eskilstuna, Sweden. 945,072.

BURNER FOR LIQUID FUEL. Henry E. Brett, Los Angeles, Cal. 945,080.

SMOKE-PREVENTING DEVICE. Judson R. Morton and William H. Stoddard, Detroit, Mich. 945,339.

BOILER-CIRCULATING DEVICE. Frank H. Newhall, Juneau, Alaska. 945,977.

TUBE CLEANER FOR WATER TUBES IN STEAM BOILERS. Elmer E. Hauer, Springfield, Ohio, assignor to the Lagonda Manufacturing Co., Springfield, Ohio, a Corporation of Ohio. 945,125.

WATER-LEVEL INDICATOR FOR BOILERS. John J. Dewey, Hartford, Vt. 945,075.

WATER GAGE. Henry C. Burns, Marshall, Mich. 946,106.

WATER-FEED REGULATOR. Willard A. Kitts, Sr., and Willard A. Kitts, Jr., Oswego, N. Y. 946,139.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., George Westinghouse; sec., Calvin W. Rice, Engineering building, 29 West 39th St., New York. Monthly meetings in New York City. Spring meeting at Atlantic City, May 31 to June 6.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff, Denver, Colo.; sec. and treas., Frank M. Tait. Association York. Next annual convention, St. Louis, Mo., May 23-28.

ENGINEERS' CLUB OF PHILADELPHIA

Pres., William Easby, Jr.; sec., W. P. Taylor, 1317 Spruce St. Regular meetings 1st and 3d Saturdays.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U. S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railway, Cleveland, O.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, 803 Fulton building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., L. B. Stillwell; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly, excepting July and August.

ENGINE BUILDERS' ASSOCIATION OF THE UNITED STATES

Pres., A. L. Merriam, Oswego, N. Y.; sec., C. H. Sembower, Reading, Pa.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, W. S. Cadwell, Chicago, Ill.; sec., Thomas H. Jones, 244 Eighth street, N. E., Washington, D. C. Next convention, Buffalo, N. Y., August, 1910.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 525 Manhattan building, Chicago, Ill. Next convention, Rochester, N. Y., September, 1910.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next convention, Philadelphia, Pa., June, 1910.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio.

MASTER STEAM BOILER MAKERS' ASSOCIATION

Pres., J. H. Smyth; sec., Geo. M. Clark, 1337 N. Maplewood Ave., Chicago, Ill.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee Peoria, Ill. Next convention, Denver, Colo. September, 1910.

NATIONAL DISTRICT HEATING ASSOCIATION.

Pres., A. C. Rogers, Toledo, O.; sec. and treas., D. L. Gaskill, Greenville, O. Next annual meeting at Toledo, O., May, 1910.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS.

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, January 16-21, 1911, January 16-21, 1911.

MOMENTS WITH THE Advertising Editor

A Department *for* Subscribers Conducted *by the* Business End *of* Power *and the* Engineer

How many of you knew the late Jed Andrews?

Jed was as fine a type of the real old dyed-in-the-wool engineer as you could hope to meet.

Rumor has it that he was born in an engine-room and had to have his milk fed to him from a tallow grease cup.

Jed liked to talk; there's no doubt of that. But nobody objected; in fact they encouraged it, because Jed usually had something worth while to say.

We remember we were sitting in his office one day when a young assistant, a favorite of Jed's, came in with a copy of POWER, threw it on the desk and said:

"Paradise! This paper's half advertisements! What *I'm* paying for is reading matter."

"Sit down, son," said Jed quietly.

And we knew something was coming.

"Son," said Jed, carefully removing a well blackened pipe, "ever and anon, and sometimes oftener, I've seen a young fellow like you raise up on his hind legs and bray about the advertisements in POWER. The worst flea-bitten old razor-back mule down in Texas couldn't make half the noise for twice the cause.

"Let me tell you, son, that you'd make just as conspicuous a success of running a refrigeration plant in Hell as the publisher would trying to run his paper without advertising.

"You think that the advertisements are like the vermiform appendix—just put there to make money for the doctors.

"Forget it!

"If it weren't for the advertisements in newspapers, magazines and technical papers like POWER, you and me and about everybody else but a few bloated bond-holders would be minus our reading matter outside of books—and they go out of date the day they're published.

"The good technical paper that costs us anywhere from $2.00 to $8.00 per year would cost ten times as much.

"And where'd we be then, huh?

"Back in a fog, son, groping around hollering for help.

"When you had to pay ten cents per for the Daily Screamer you'd go without, and you couldn't keep up with the Society News. First thing you know you'd be wearing yellow shoes with your spike-tailed suit.

"And you're thinking that would be a terrible bad break, and I'm thinking it don't make an awful lot of difference what shoes you wear, but I'd hate like thunder to see you start up the old Corliss without heating her up first. Because, sonny mine, there'd be a nice little grave here, and a pretty tombstone reading 'Man Wanted.'

"The world moves ahead fast because the papers spread the news of what the other fellow is doing and they spread it quick. They've got railroads and telegraph working for 'em.

"With your theories about advertising, you want to put the papers out of business.

"Do you know how this firm of ours grew so fast that they need an assistant engineer? Just because they advertised their goods and sold more of 'em that way. A lot of folks owe their jobs to advertising.

"But that's about the smallest part of the whole business so far as you and I are concerned.

"Truth is, the ads are just as *instructive* as any other part of the paper. And that's why we need 'em and ought to read 'em.

"I remember some years ago when all the ads were just 'cards.' Some fellow'd stick his name and address in a paper and tell what he made, and let it go at that. They helped me find where I could buy what I wanted, but they were about as enthusiasm-inspiring as a chunk of mud.

"Things have changed since. You pick up that POWER again and look her over. The advertising pages are chock full of information. I tell you when a man spends good money to advertise, his stuff is pretty near right, because he depends on you and me, if we buy his goods, to *recommend* 'em—and that's how he gets his money back.

"Now, I'll say this much. I expect you to not only read the paper, but the ads too, and when you find something that will help out this plant, you put it up to me. I may overlook some things myself. Then we'll write the manufacturer for all the details, and if our judgment says it's all right, why! in she goes!

"But never let me hear you talk about the advertising section as if the publishers were trying to put something across touching on and appertaining to a lemon.

"As it is, the POWER publishers are giving you something like 2400 pages a year of good reading matter, equal to 6000 pages of ordinary book size, and they're only charging you $2.00 for it.

"Some time when you've got a bottle of Bromo-Seltzer handy, sit down and figure up how much paper and ink and printing-work go into a journal like POWER, then add something more for brains, don't forget postoffice charges and you'll pile up a total that will make you gasp, and *then* you're only *half* finished.

"If you want more, you're a hog, son, a regular down-right hog.

"Read the ads, son, read 'em. Don't be like the girl who sits in the next room and listens—she gets only imaginary thrills and no benefits. Read the whole paper."